Materials
in Design Engineering

GUIDE TO FERROUS CASTINGS

METAL SHOW PREVIEW

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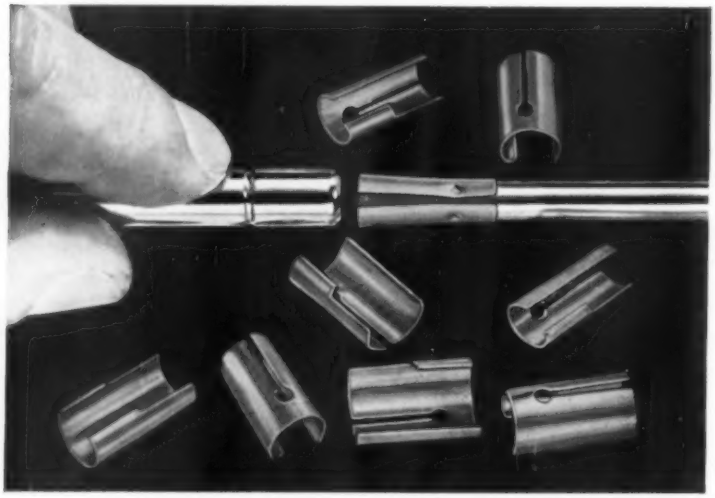
OCTOBER, 1960

CREATIVE COST CUTTING

Selecting the metal to fit the job can give you surprising savings in total cost



Small spring clips between telescoping parts of auto radio antennas must maintain electrical contact, hold parts firmly, give smooth sliding action. Brach Manufacturing Division of General Bronze Corp., Newark, N. J., found that spring clips of Duraflex®, Anaconda superfine-grain phosphor bronze, gave best positive electrical contact and improved smooth action in Brach Auto Antennas over original clips made of premium metals. The clips stand up in constant use, spot welding and fabrication are easier—and costs are about 25% lower.

In this G-E Automatic Coffee Maker control, a thermostat turns cam actuating switches—for high heat to brew coffee, for low heat to keep it warm. At first, upper switch element was an assembly of blade, bushing, and locking nut. Tinnerman Products Inc., Cleveland, Ohio, engineered a one-piece Speed Clip to replace it—by forming one thread in the blade and two prongs to lock the screw (see inset above). This simplification called for a superior phosphor bronze. Tinnerman found it in Duraflex, Anaconda superfine-grain phosphor bronze. It has higher tensile strength and endurance limit for long-lasting dependability—greater formability for economical manufacture. The result: unit costs were cut— and G-E assembles controls faster, more easily.

Quality control and cost reduction can go hand in hand. The secret is often simply matching the metal to the job. And Anaconda specialists, starting with 93 standard alloys, can offer an almost unlimited number of combinations of useful properties. For creative help in meeting your problems, write Anaconda American Brass Co., Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

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Anaconda American Brass Company

OCTOBER, 1960 | VOL. 52, NO. 4

Materials in Design Engineering

FORMERLY MATERIALS & METHODS

APPLICATION OF METALS, NONMETALLICS, FORMS, FINISHES

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What's New in Materials

Engineering & Design

CONTINUED ON PAGE 3 →

CONTINUED FROM PAGE 1

NEXT MONTH

Automobiles: What Materials Are Next?

Short-Time, Rapid-Heating Tests for Aerospace Materials

Flame Retardant Coatings for Plastics

How to Use Probability Paper to Solve Materials Problems

Rare Earths: Sixteen New Metals Are Ready for Use

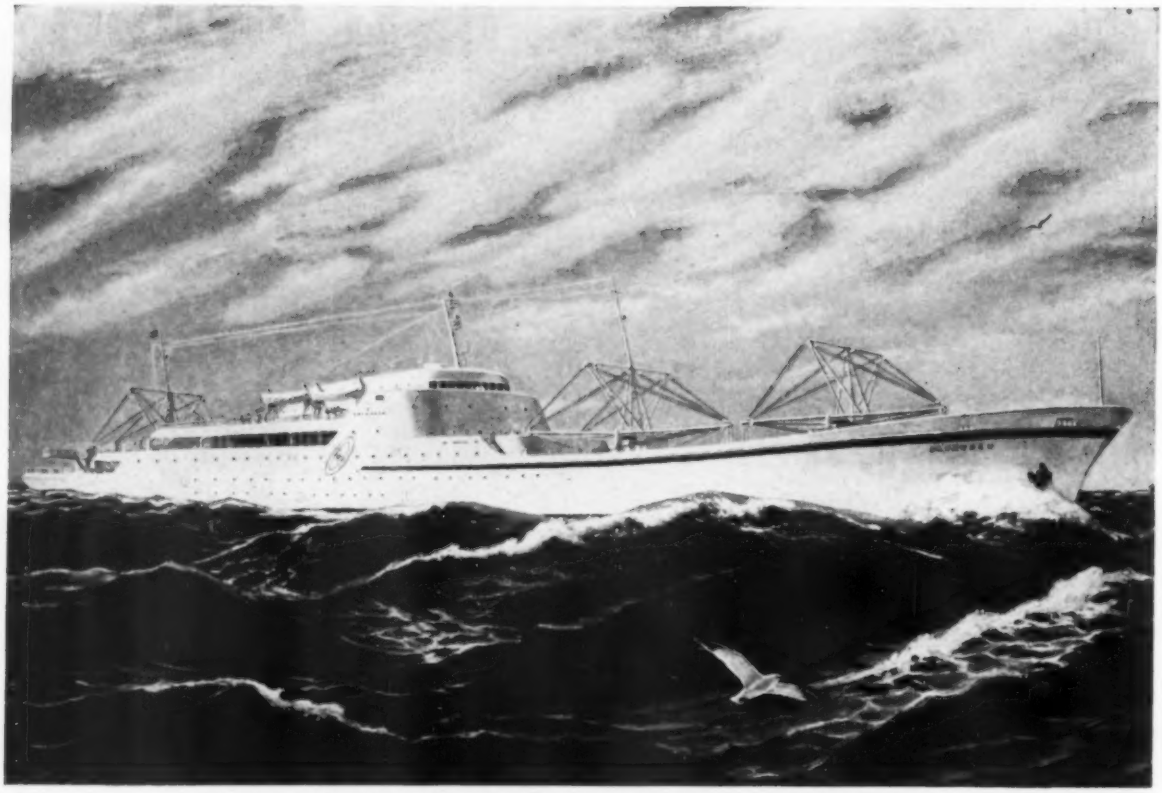
Plastics for Atom Smashers

Vanadium-Columbium Alloys for High Temperatures

Split Die Forging Produces Intricate, No-Draft Parts

A Quick Temperature Conversion Chart

What Quartz Fibers Can Do for Reinforced Plastics



N.S. Savannah, built by New York Shipbuilding Corporation, can sail for three years on 138 pounds of nuclear fuel. A conventional ship would burn 80,000 tons of oil.

'round the world 13 times with fuel to spare ...the first nuclear-powered merchant ship

This is the Nuclear Ship Savannah, first of her kind. Capable of sailing over 350,000 nautical miles without re-fueling, she points the way to a new era in transport and travel at sea.

Her uranium oxide fuel is packaged in tubes of Nickel Stainless Steel...*more than 5,000 of them.* The fuel-element cans that hold these tubes are also made of this strong, corrosion-resisting metal.

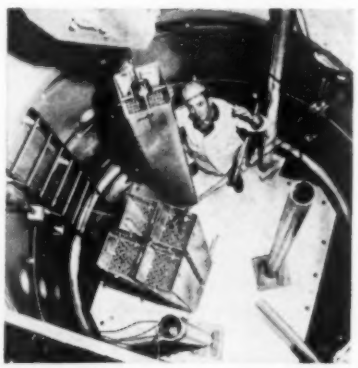
Wherever you look, inside the reactor, almost everything is Nickel Stainless Steel. 200,000 pounds of it are used in the reactor area: for the lining of the reactor vessel, for the coolant pumps and tubing that circulate corrosive "hungry" water, and for the control rods inside the atomic pile.

At the design stage, engineers anticipated the high operating pressures—1,750 pounds per square inch—and temperatures up to 508 °F. They selected Nickel Stainless Steels to provide the strength and resistance to heat and corrosion needed to withstand these rigorous conditions.

So the next time you need more from a metal, remember the N.S. Savannah. Nickel Stainless Steel, or another Nickel alloy, may be the solution to *your* problem, too.

A note to Inco will bring you "First Steps Towards Solving Specific Corrosion Problems" and "High Temperature Worksheet"... simplified forms you can use to describe your metal problem. Perhaps our technical staff has information that will help you find the solution.

The International Nickel Company, Inc.
67 Wall Street New York 5, N.Y.



Inside the reactor nearly everything you see is Nickel Stainless Steel to withstand corrosion, high temperatures and pressures that hit 1,750 psi. Reactor built by Babcock & Wilcox Co., Barberton, Ohio.

INCO NICKEL

NICKEL MAKES ALLOYS PERFORM BETTER LONGER

What's new IN MATERIALS

...AT A GLANCE

Recrystallized graphite, with two to three times the high temperature strength of conventional graphites, joins two other graphites introduced in recent months (see M/DE, Feb '60, p 16 and Aug '60, p 165). The newer graphite is made by what is claimed to be a revolutionary hot working process that is more akin to metallurgical than ceramic technology. In recent rocket motor tests, nozzles made of recrystallized graphite proved to be as good as, and in some instances substantially better than, other high temperature materials such as tungsten and pyrolytic graphite. (More details next month.)

Source: National Carbon Co., Div. of Union Carbide Corp., 100 E. 42nd St., New York 17.

A new leaded nickel-copper alloy is said to have good corrosion resistance, high tensile and yield strengths, high electrical conductivity, and free machining characteristics. The precipitation-hardening alloy is suitable for electrical contacts, connectors and other electrical and electronic parts. It is presently supplied in round rod 3/32 to 1¼ in. in dia.

Source: American Brass Co., Waterbury, Conn.

Stronger and longer-lasting wood products can be obtained by using a new carbon steel thread insert that is said to produce a fastening system with twice the holding power of standard wood fasteners. Reason: its pitch, which is twice as large as that of standard machine screws, leaves thick sections of wood between threads and eliminates the breaking-up of wood fibers.

Source: Heli-Coil Corp., Shelter Rock Lane, Danbury, Conn.

A new tooling material—magnesium phototemplate and layout sheet—is available in widths up to 60 in., in lengths up to 168 in., and in thicknesses up to 0.090 in. The material is said to be extremely flat, easy to machine, lightweight, and dimensionally stable. It can be used for both the diazo and blueprint methods of reproduction.

Source: Dow Metal Products Co., Div. of Dow Chemical Co., Midland, Mich.

A dry lubricant in the form of TFE powder is now available. The new lubricant can be used on wood, ferrous and nonferrous metals, plastics, glass, leather and other materials. It is said to be odorless, colorless, tasteless, nonstaining, and suitable for use over the temperature range –450 to 400 F.

Source: Polydoris Products Corp., 5306 W. Lawrence Ave., Chicago 30.

Closer tolerance and lower cost corrugated metal is promised with the development of a new process in which ferrous or nonferrous metals are folded, rather than drawn, into corrugations. The developer says die costs range from $800 for a simple design to $3500 for a complex design. Folded aluminum, brass, copper, and carbon and stainless steels can be supplied in gages ranging from 0.002 to 0.030 in. at a tolerance of ±0.001 in.

Source: Twin Coach Co., 30 S. Cayuga Rd., Buffalo, N. Y.

Colored titanium parts are being turned out by a new process (details not disclosed) in which the metal is coated in brilliant and uniform colors without the use of harm-

ful dyes or paints. The developer says colors can be applied to all titanium alloys. The colored coatings are durable and have good resistance to fading at temperatures up to 600 F. They are expected to be used for decorative purposes on commercial products and as identification on fasteners, valves, nuclear reactor parts, and pipes and fittings.

Source: Hi-Shear Corp., 2600 W. 247th St., Torrance, Calif.

A new flux-coated silver brazing alloy is said to permit the joining of ferrous and nonferrous metals at a speed three times faster than with conventional silver brazing alloys. Reason: the new product eliminates the need for a separate flux which has to be mixed, applied and dried separately before the application of a conventional brazing alloy. The developer says deposits are cadmium-free, and thus the brazing alloy can be used safely on processing equipment.

Source: Eutectic Welding Alloys Corp., Flushing, N. Y.

Three new man-made fibers that have no counterparts in the Western world have been produced in Russia, according to a recent report. The fibers are: 1) Enant, a nylon 7; 2) Ftorlon, a fluorine-containing copolymer with good chemical resistance; and 3) Vinitron, a combination of a cellulosic material with chlorinated polyvinyl chloride.

Source: R. C. Laible, Headquarters, Quartermaster Research and Engineering Command, Natick, Mass.

A new radiation resistant material—pure gold laminated to rubber-coated nylon—is now available in the form of continuous rolls measuring 36 in. wide by 100 yd long. The gold-nylon laminate can be fabricated into parts for use in electronic devices and missiles.

Source: Lamart Corp., 16 Richmond St., Clifton, N. J.

Magnesium castings can be sealed and primed in one operation by using a new type anodize treatment. The developer says castings sealed by the process withstand air or water pressures of at least 40 psi, and heating to at least 700 F. Sealed castings also withstand high humidity, and are stable in hot engine oil, gasoline and kerosene.

Source: Dow Metal Products Co., Div. of Dow Chemical Co., Midland, Mich.

Thinner tin plate, about half the thickness of tin plate now used in can making, is presently available in weights of 45 through 60 lb per base box. Big advantages of the new tin plate are its greater strength, lighter weight and lower materials cost compared to currently used tin plate.

Source: United States Steel Corp., 525 Wm. Penn Pl., Pittsburgh 30.

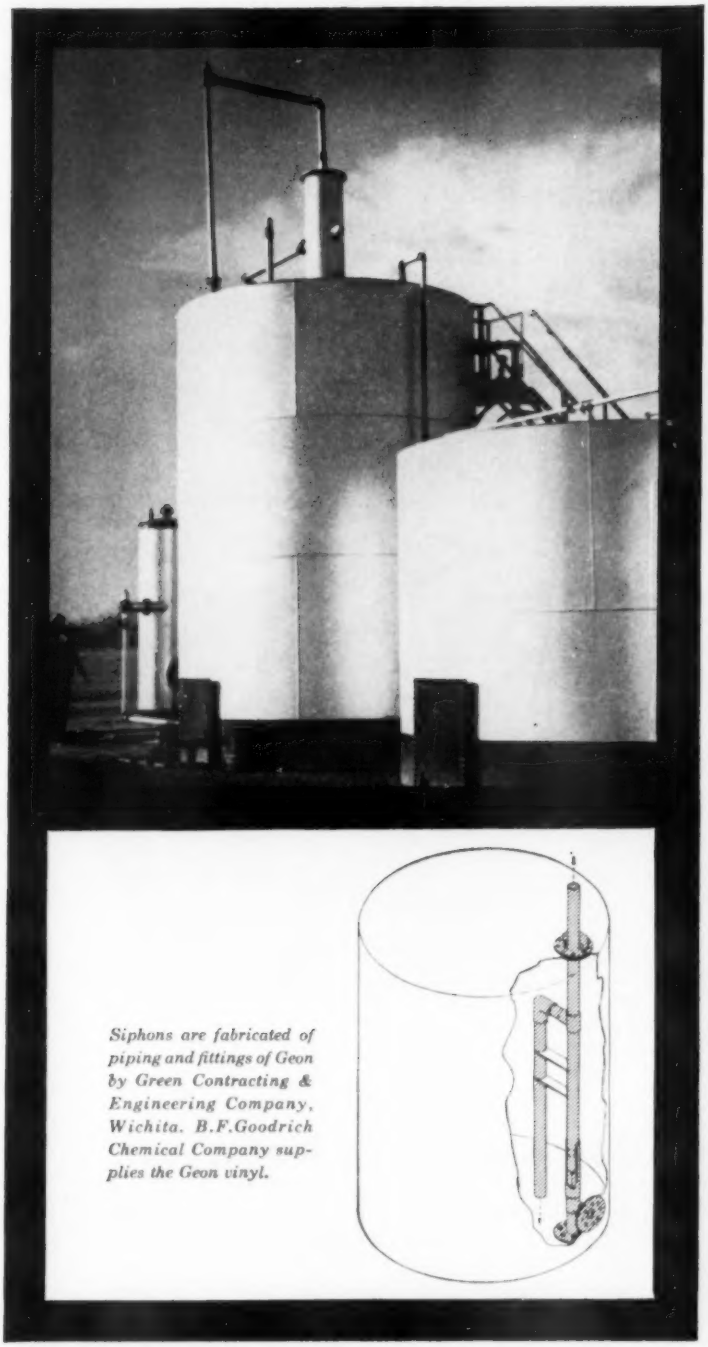
A new nickel-aluminum coating is said to protect ferrous and nonferrous metals from oxidation at temperatures up to 1800 F. The coating is obtained by electroplating nickel over the base metal and then electroplating aluminum over the nickel layer. Steel specimens protected with the composite metal coating have withstood 300 hr in salt spray tests before showing rust, according to the developer. (More details next month.)

Source: D. E. Couch, National Bureau of Standards, Electrodeposition Laboratory, Washington, D. C.

Turn to page 9 for more "What's New in Materials"

Another new development using

B.F.Goodrich Chemical *raw materials*



Siphons are fabricated of piping and fittings of Geon by Green Contracting & Engineering Company, Wichita. B.F.Goodrich Chemical Company supplies the Geon vinyl.

Siphon separates oil from brine —no corrosion

it's made of GEON

Either the oil or the salt water in these oilfield gathering tanks in Kansas can make short work of ordinary pipe. Now, with pipe and fittings fabricated of rigid Geon vinyl, there is no corrosion problem at all. Geon solved another problem too: the buildup of paraffin, common in metal pipe, was eliminated.

Geon pipe proves ideal for a wide variety of applications because of its resistance to corrosion and its impact and tensile strength. Crews especially like its light weight and easy installation. Either solvent welding or threads can be used.

Here's another example of the way that Geon vinyl solves product problems—and opens new markets. For more information, write Dept. GV-5 B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

Geon VINYLS

B.F.Goodrich Chemical Company
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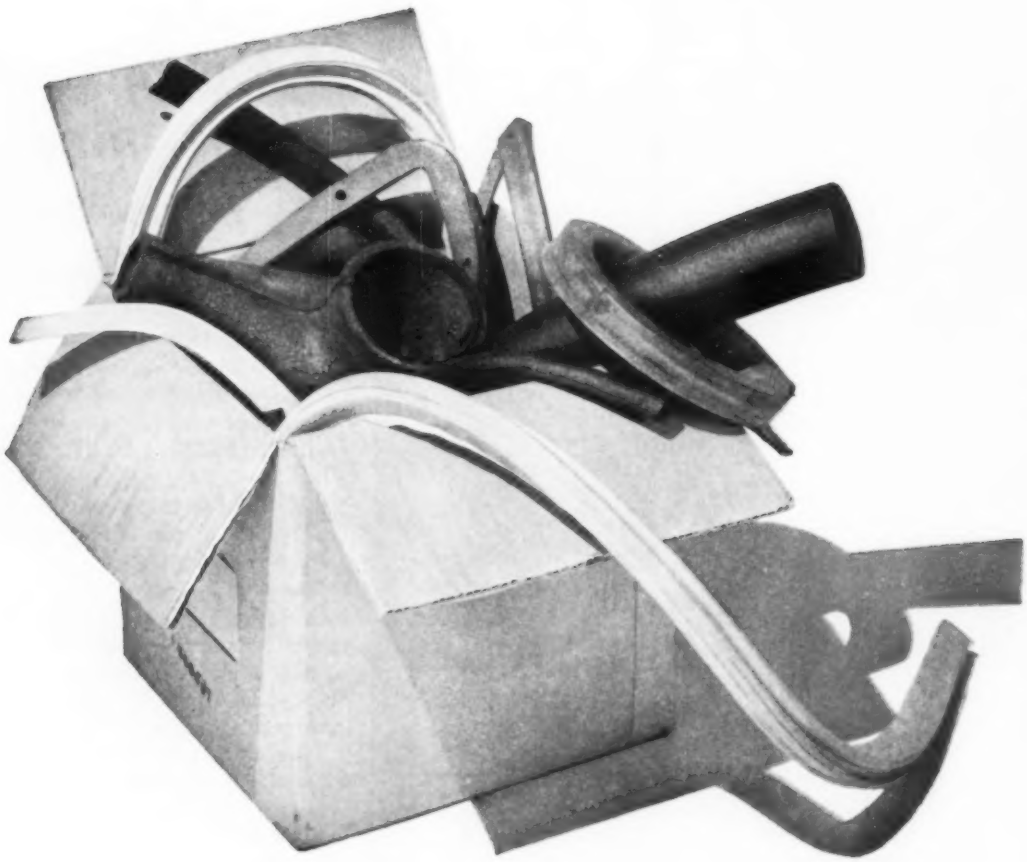
For more information, turn to Reader Service card, circle No. 373

B.F.Goodrich



If it sweats, rattles, shakes or leaks . . .

. . . it shouldn't! And if you ask B.F.Goodrich, it won't! B.F.Goodrich, as the largest producer of sponge rubber and cellular plastic, makes special or standard parts for insulation, flotation, shock-absorption, sealing, cushioning and vibration damping. And all this can be accomplished under practically every condition you can think of.

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B.F.Goodrich *industrial cellular materials*

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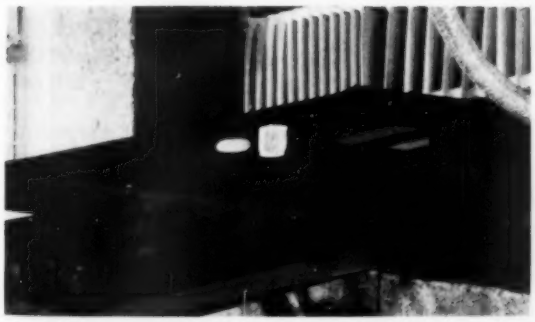
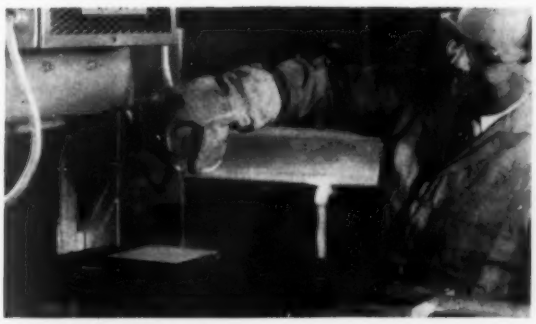
Fuse polycrystalline glass to metal and you get a

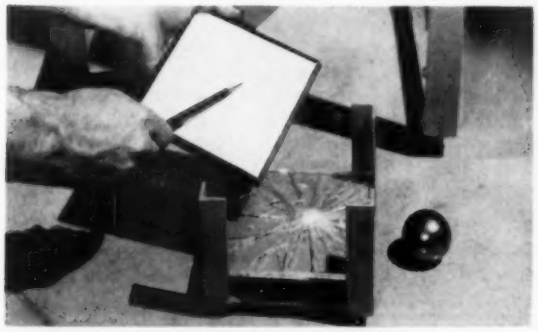
New Glass-Coated Metal for High Temperature Equipment



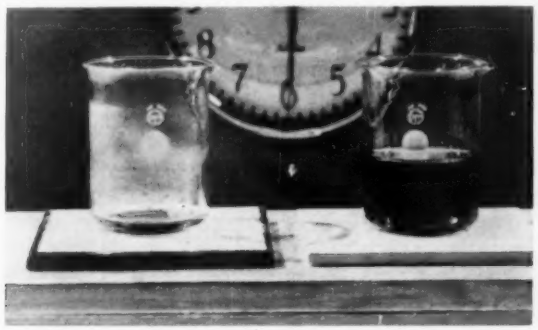
***Heat resistance**—After 10 min at 1800 F a fusion button of soda lime glass (left) has "puddled"; button made of the ceramic component of Nucerite is unaffected.*



***Thermal shock resistance**—Ice water is poured over a Nucerite specimen consisting of 0.020 in. of ceramic on 1/2 in. of mild steel which has just been heated for 15 min at 1250 F. No damage was visible.*



***Impact strength**—Steel ball dropped from height sufficient to produce impact force of 10.8 ft-lb produces only slight crushing of outer surface, scarcely discernible at tip of pencil. Three-eighth inch safety plate glass shown is shattered by same loading.*



***Thermal conductivity**—Both beakers originally contained 300 ml of colored water. The beaker at left was placed on Nucerite (0.020 in. ceramic on 3/8 in. Inconel), the beaker at right on 3/8 in. porcelain. Hot plate under both specimens was heated to 212 F. After 30 min, the beaker at left contains only 10 ml of water; the beaker at right contains 170 ml.*

■ A new process has been developed for ceramic coating of metals. The result is a composite consisting of a polycrystalline glass, a base metal, and a strong diffusion bond between them.

The polycrystalline glass, or ceramic, component of the composite is similar to Pyroceram (see M/DE, July '57, p 142).

Developed by Pfaudler Co., Div. of Pfaudler Permutit Inc., Rochester 3, N. Y., and trademarked Nucerite, the composite is primarily designed for use in chemical process equipment where operating conditions are too severe for glass-lined steel.

The new composite offers five major properties:

1. Heat resistance; e.g., it has protected molybdenum from oxidation at 1600 F.

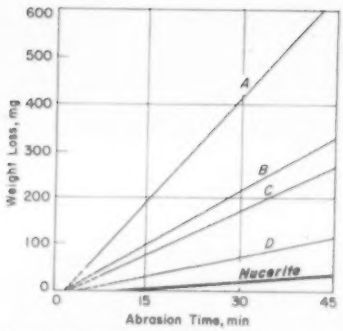
2. Excellent thermal shock resistance; e.g., it withstands shocks produced by cycling over a 1200°F temperature differential.

3. Excellent abrasion resistance, e.g., it is said to be four times more resistant than laboratory glass (see Fig 1).

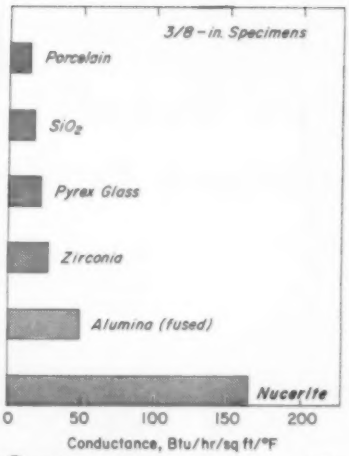
4. Thermal conductivity higher than that of hard glass and most other high temperature ceramics (see Fig 2).

5. Good impact strength.

In addition to uses in chemical processing equipment, such as reactor vessels and heat exchanger tubing, the coating is said to offer promise as a protective coating for the reactive metals, and for



1—Abrasion resistance *of Nucerite is compared with that of four enamels by the standard PEI abrasion test.* (Curves for enamels from Proceedings PEI Forum, 1954.)



2—Heat transfer rate *for 3/8-in. thick specimens of Nucerite is much higher than that of the same thicknesses of other ceramic materials.*

use in mechanical seals and bearings. Design limitations are virtually identical to those of glass-lined steel.

According to Pfaudler, a number of glass compositions are available to match the desired base metal in thermal expansion. Metals to which the coating can be applied include: conventional carbon steels; high nickel alloys, such as Inconel or Hastelloy; and the reactive metals, such as tantalum, columbium or molybdenum.

How the composite is made

The selected glass, containing nucleating agents, is applied to the metal by any of the conventional methods used to glass-line steel, e.g., wet spray, slushing or hot dust. After a ground coat has been applied it is fused to the metal, producing a diffusion bond. Subsequent layers of glass are applied and fused until sufficient thickness is built up. The final glass-metal composite is then heat treated.

During heat treatment the nucleating agents form submicroscopic crystallites, each crystallite acting as a center of crystal growth as the heat continues. The end product is a fine-grained crystalline coating.

The internal structure of the coating is not completely understood as yet, according to C. L. Betzer, Pfaudler's technical manager. At the metal-ceramic interface there is definitely reciprocal diffusion producing a cermet phase of unidentified composition. Within the ceramic coating the crystalline areas are, to some degree, laminar.

Although overall crystalline content of the ceramic component is about 30-50%, crystalline concentration is greater at interfacial areas between subsequently applied layers of glass. This laminar affect is thought to be due to some migration of nucleating agents to surfaces during application of the coating.

Availability, cost

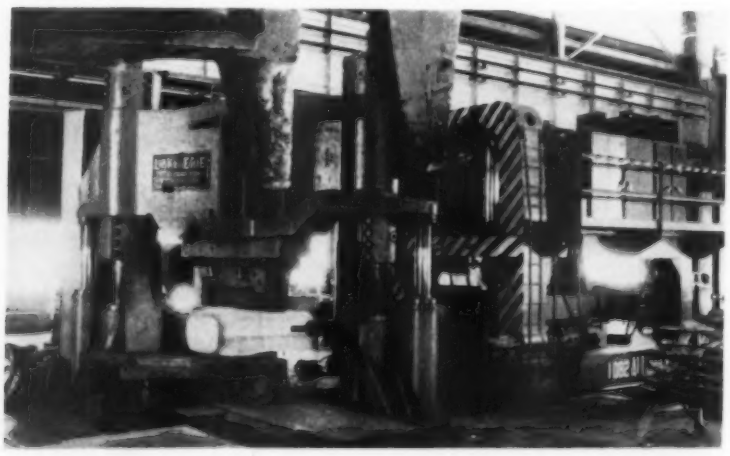
All Nucerite will be custom fabricated by Pfaudler. Although the company has successfully coated and tested a variety of parts, the process is still somewhat developmental. At present an extended evaluation period of selected field testing is planned.

Costs are difficult to estimate now. In general, however, Nucerite will be more expensive than glass-lined steel.

For more information, circle No. 600

Large Tool Steel Forgings

New forging press *handles 30,000-lb forgings*



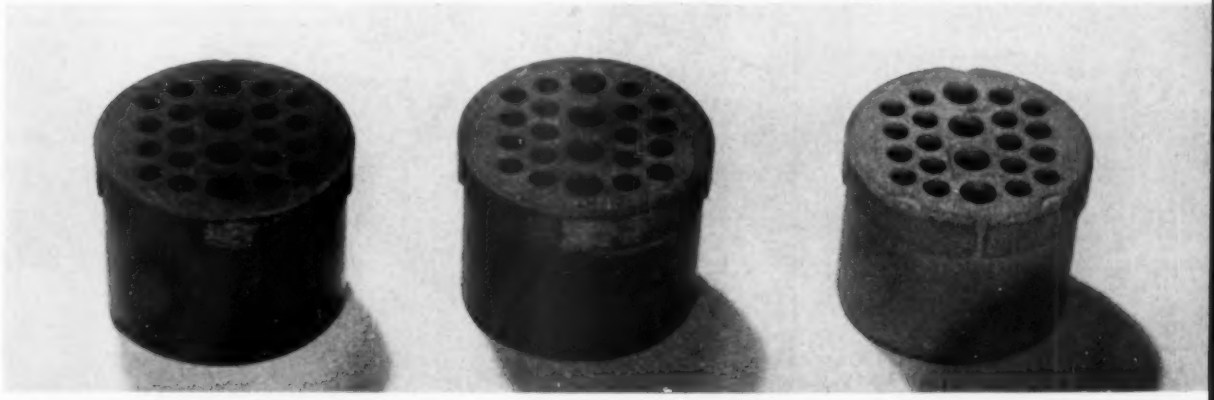
■ Allegheny-Ludlum Steel Corp. recently installed a new forging shop at its Dunkirk, N. Y. plant to handle hard-to-work alloys such as tool steels, stainless steels and high temperature alloys.

Principal feature of the new forge shop is a 2000-ton, general purpose oil hydraulic forging press (see photograph). Only two columns support the overhead structure of the press and these are arranged diagonally to allow forging of wider pieces.

Ingots weighing up to 30,000 lb can be forged on the new press. Tool steel structural parts for supersonic aircraft have already been forged. Disks for extrusion dies have been forged in sizes up to 42 in. dia and 26 in. thick.

High temperature connectors *use inserts molded of the new silicone compound.*

Amphenol-Borg Electronics Corp.



Moldings retain form *when heated.* Left—*Insert as molded.* Center—*After 2 hr at 700 F, 18 hr at 800 F, 2 hr at 900 F, and 15 min at 1000 F.* Right—*After direct firing for 6 hr at 1100 F.*

New Molding Compound for 700 F Electrical Uses

■ A new mineral-filled silicone molding compound, primarily designed for high temperature electrical insulation, features: 1) long-term stability at 700 F, 2) excellent thermal shock resistance (over a range of −67 to 500 F), 3) a low dissipation factor of 0.002 at 10^6 cps, and 4) arc resistance greater than 400 sec.

This compression or transfer molding compound, designated M-6-4156, was developed by Dow Corning Corp., Midland, Mich., in cooperation with Amphenol-Borg Electronics Corp., research personnel to meet the most stringent high temperature requirements of advance connector design. Other promising applications include fuses, coil forms, relay parts, tube bases, contactors, arc barriers and switch parts.

The material is currently being produced in semicommercial quantities, and is available at a developmental price of $5.50 in 300-lb quantities.

Properties

The tables on the next page list typical properties of the compound, both postcured and after thermal aging at various temperatures.

A curious characteristic of the material is its form stability at temperatures of over 2500 F. At such temperatures the organic constituents have evidently burned off, leaving a ceramic-like silica body. Unfortunately, the body is quite porous, which limits its utility. Development work is now aimed at reducing such porosity. Data given in the table for specimens aged 3 hr at 1800 F indicate the properties of the material in its ceramic-like form.

Amphenol connectors first successful use

The compound was initially developed to meet the requirements of Amphenol-Borg Electronics Corp.'s high temperature (496 construction) AN/MS type connectors. According to V. Elarde, Director, Materials and Components Research, of Amphenol-Borg, the material has exceeded the original requirements.

Initial objective was to produce a connector serviceable for a minimum of 8 hr at 600 F. The compound also had to be usable with available production techniques and adaptable to existing tooling.

TYPICAL PROPERTIES OF MINERAL-FILLED SILICONE MOLDINGS

Condition →		Post-Cured[a]	After Aging[b]			
			72 Hr, 500 F	72 Hr, 700 F	72 Hr, 800 F	3 Hr, 1800 F
MECHANICAL PROPERTIES						
Flex Str, 1000 psi	D790	8	7.9	5	2.2	6
Flex Mod of Elast, 10^6 psi	D790	2.2	—	1.6	—	—
Compr Str, 1000 psi	D695	15	16.3	12	7.5	15.4
Compr Mod of Elast, 10^6 psi	D695	0.5	—	0.6	—	—
Ten Str, 1000 psi	D638	3.5	—	1.6	—	—
Izod Impact Str, ft-lb/in. notch	D256	0.35	0.40	0.38	0.43	0.49
PHYSICAL PROPERTIES						
Specific Gravity		2.82	2.82	—	2.73	2.68
Water Absorption (24 hr, 77 F), %	D570	0.13	0.05	0.19	2.0	7.7
Dimensional Stab (shrinkage), in./in.[c]		0.0044	0.0022	—	0.006	0.019
Weight Loss, %		—	1.3	—	5.08	8.15
Heat Dist Temp (264 psi), F	D648	>900 F	—	>900 F	—	—
Flammability	D635	Self-extinguishing				
ELECTRICAL PROPERTIES						
Arc Resistance, sec	D495	420	420	420	420	420
Dielectric Str, v/mil						
Air	D149	200[e]	>207	210[e]	>210	52
Oil	D149	400	389	325	279	133
Vol Resistivity, ohm-cm						
Dry	D257	3.6×10^{14}	3.6×10^{14}	4.6×10^{12}	2.2×10^{11}	9.5×10^{13}
Wet[d]	D257	8.5×10^{13}	8.5×10^{13}	5.5×10^{10}	—	—
Ins Resistance, ohms						
Dry		3.3×10^{14}	—	1.23×10^{12}	—	—
Wet[d]		3.35×10^{12}	—	5.23×10^{10}	—	—

[a]Two hours at 500 F. [b]Tested at 77 F.
[c]Molding and postcure shrinkage is 0.0044 in./in. Values given after aging indicate additional shrinkage caused by soak at temperature.
[d]24-hr immersion in water at 73 F. [e]After 96 hr at 73 F and 96% RH.

TABLE 2—ELECTRICAL PROPERTIES

Dielectric Constant[a]	
Dry	
60 Cps	6.4
10^6 Cps	6.3
Wet[b]	
60 Cps	6.4
10^6 Cps	6.3
Dissipation Factor[a]	
Dry	
60 Cps	0.003
10^6 Cps	0.002
Wet[b]	
60 Cps	0.004
10^6 Cps	0.002

[a]ASTM D150.
[b]24-hr immersion in water at 73 F.

The resulting compound is said to offer a considerable margin of improvement in both thermal shock resistance and thermal stability. Mr. Elarde points out the following performance improvements:

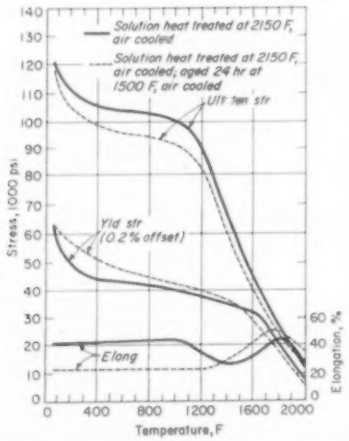
- Compound does not crack during thermal cycling.
- Inserts made with the compound perform well for several hundred hours at 700 F—much longer and at 100 °F higher temperature than required.
- Inserts can be molded easily by conventional compression or transfer molding techniques.

Although performance data are incomplete as yet, insulation resistance vs temperature is as follows (values in kilomegohms):

Temp, F	
Room	2000
300	1500
400	1500
460	1500
1000	1

These data were obtained using 1/16-in. dia electrodes spaced 3/16 in. apart in a 1/16-in. specimen.

For more information, circle No. 601



***Mechanical properties** of 0.063-in. thick sheet of Haynes 56 alloy.*

High Strength, Oxidation Resistant Alloy

■ Haynes 56, an alloy of chromium, nickel, cobalt and iron, has been announced by Haynes Stellite Co., 270 Park Ave., New York 17, N. Y. The alloy has good oxidation resistance: in continuous exposure to dry air for 100 hr at 1900 F its oxidation rate was only 0.024 in. per year.

Nominal composition of the alloy is: nickel, 13%; cobalt, 11.5%; chromium, 21%; molybdenum, 4.5%; tungsten, 1.5%. Small amounts of carbon, nitrogen, columbian, silicon and manganese are also present. Since the alloy is solid solution strengthened, no further heat treatment is necessary after solution treatment at 2150 F.

Mechanical properties of Haynes 56 are shown in the accompanying graph.

Haynes 56 is available as sheet, bar, wire and coated welding electrodes. Parts can also be produced by sand, investment and shell casting techniques.

For more information, circle No. 602

***Fusion welding columbium** is done in an inert atmosphere. This chamber houses standard inert-gas shielded arc welding equipment and the copper tooling fixtures for positioning work (shown above).*

Welding and Brazing Two Columbium Alloys

Two high temperature alloys have been joined by fusion and resistance welding, as well as brazing, for aircraft and missile applications. Here are joining procedures and the joint properties obtained.

by C. F. Burrows, M. M. Schwartz and L. J. Gagola,
Baltimore Div., Martin Co.

■ Research engineers at Martin Co.'s Baltimore Div. have successfully joined columbium alloys by fusion and resistance welding and brazing. These refractory alloys have been developed for use in missiles and space vehicles where operating temperatures will be as high as 3000 F. The goal was to weld and braze honeycomb structures from thin sheet stock. The two columbium alloys used were Fansteel 82 (33 tantalum–0.7 zirconium) and Du Pont D31 (10 titanium–10 molybdenum).

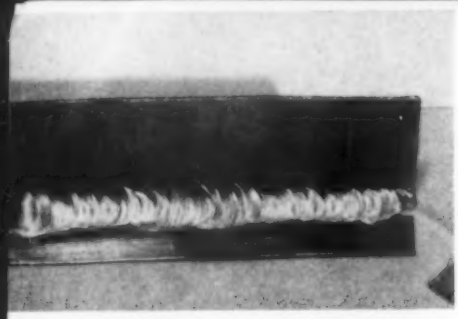
The difficult joining problem

Joining columbium and its alloys requires more exacting process control than required for standard structural metals. Problems affecting the fusion of these refractory alloys are:

High melting temperatures—Fansteel 82 and Du Pont D31 melt at 4550 F and 4100 F respectively. These temperatures require considerable heat or welding current to melt and flow the metal. Therefore, it is particularly difficult to weld thin gages where burn through is apt to occur. High welding currents concentrated long enough to get melting also create thermal gradients within the metal and cause distortion.

Gas absorption—Columbium and its alloys pick up interstitial impurities (hydrogen, oxygen, nitrogen and carbon) when exposed to high temperatures. These embrittle the base metal, fusion zone and heat-affected area.

Recrystallization and grain growth—The molten weld metal on solidification will form large dendritic grains, with recrystallization occurring in the heat-affected zone when heating time and amount of previous cold working permit. Recrystallization, which occurs on heating columbium above about 1800 F, removes the effects of cold working and thereby lowers mechanical properties.



1—T-joint *fusion weld made with 0.032-in. Fansteel 82 columbium.*

2—Brittle precipitate *in fusion butt welded D31 appears as the dark areas (left) between the weld bead and the base metal (65X).*

TABLE 1—MECHANICAL PROPERTIES OF FUSION WELDED FANSTEEL 82
(0.032-In. Sheet)

Properties	Control (unwelded)	Weld Panel 1	Weld Panel 2
Ult Str, psi	68,480	65,580	58,520
Yld Str, psi	49,210	44,460	36,890
Elong (in 2 in.), %	13	9.2	14
Mod of Elast, 10^6 psi	17.4	14.9	17.2
Failure Location	—	Parent metal	
Bend Test	No cracking when specimens were bent 180° using a punch radius as small as 0.315 in.		

Fusion welding

Weldability

Fansteel 82—The fusion weldability of Fansteel 82 is superior to that of conventional stainless steel alloys known for their good welding characteristics. Typical butt and T-joints were successfully prepared from sheet gages ranging from 0.002 in. to 0.032 in. The metal, whether consisting of melted edges or added filler wire, flowed readily and made smooth welds. Occasional weld metal depression, or "suck back," occurred on the penetration side of fillet welds in 0.032-in. T-joints. Caused by high heat input and metal thinness, it can be minimized by a welder experienced in controlling heating or by increasing the metal gage.

Fig 1 shows typical T-welds in 0.032-in. Fansteel 82. Mechanical properties of the test welds are given in Table 1.

Du Pont D31—Du Pont D31 is weldable but it has a strong tendency to crack. Examination of three welded specimens (two cracked between the weld bead and the heated zone; the third did not crack) showed a dendritic cast zone with either solid solution melting or precipitate in the melt-metal junction. High temperature diffusion techniques were tried, with varying success, to eliminate this brittle precipitate (shown in Fig 2). Further investigations are being conducted by Martin Co. and Du Pont Research Laboratories to determine if D31 columbium has merit as a structural high-temperature material.

Welding technique

Since columbium and its alloys are very sensitive to interstitial contamination, the fusion welding was done in a chamber that was effectively purged by an inert atmosphere. Dried argon, dried helium, and mixtures of the two gases were used in the chamber and in the torch. Helium was preferred because it provides better purging and gives a hotter arc. The welder was a standard tungsten arc unit using a d.c. power source and a 3/32-in. dia tungsten electrode. The chamber and positioning fixtures are shown in the photograph at the beginning of this article.

Plates to be welded were positioned between copper tooling fixtures and the chamber purged until all evidence of oxygen contamination was eliminated. Atmospheric purity was checked by welding scrap titanium until the weld showed a clear bright surface. When the chamber was purged, gas flow in the chamber was adjusted to 30 cu ft per hr and in the torch to 10 cu ft per hr.

Resistance welding

Weldability

Resistance welding studies were made on 0.002, 0.005, 0.010 and 0.032-in. Fansteel 82 and on 0.040-in. Du Pont D31.

Fansteel 82—Sheets of Fansteel 82 were easier to resistance weld than commercially pure columbium. Less electrode-to-metal sticking occurred so more welds could be made before redressing the tips. In addition, the weld zone was more ductile and showed less evidence of sheet interface in the welds.

Spot welded surfaces tended to discolor and show evidence of considerable copper pickup. The electrode tip frequently had to be cleaned and reshaped to prevent sticking.

Characteristics of the various foil thicknesses:

0.002 in.—Frequent cleaning or redressing of the electrode was required to overcome sticking and tearing.

0.005 in.—Showed polycrystalline grain size but the foil inter-

face line could not be removed. Average shear strength was 60 lb with pull-out from both foils.

0.010 in.—Some inconsistency because of electrode deterioration. The first three welds made with clean class 2 copper tips had a shear strength of 140 lb with button pull-out from one or both surfaces.

0.032 in.—Weld structure was good. Average shear strength was 862 lb for welds made with class 1 copper electrodes and 916 lb for those made with class 2. The softer class 1 tips tended to mushroom easily, but even with the harder class 2 tips redressing was necessary after every five spots.

Du Pont D31—Resistance welding Du Pont D31 was not successful when the settings used for Fansteel 82 were used. Multiple impulse welding, however, eliminated much of the electrode sticking problem. Less power is used for multiple welds, and cooling between impulses further reduces sticking. Sheets of 0.040-in. D31 were successfully spot welded. Note the fine-grain weld layer in Fig 3. No shear tests were made because of the shortage of material.

3—Spotweld *in Du Pont D31 columbium sheets. Weld nugget shows the effect of multiple impulse resistance welding; note fine grain formation next to coarser structure (55X).*

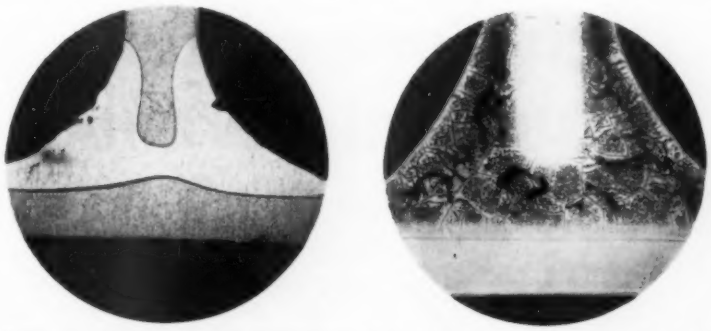
Welding technique

Fansteel 82 foil was shaped and welded into honeycomb cores for brazing into sandwiches. Core nodes were welded with stainless steel equipment using a 100-kv power source. The bottom electrodes were ¼ in. copper fingers that also held the work. The top electrode was a copper wheel, hand drawn over the metal to make intermittent welds approximately 1/32 in. apart.

Brazing

The first brazing studies, conducted for Martin Co. by Du Pont's Experimental Station, used only pure titanium and platinum for brazing at 3300 F. Platinum eroded the base metal severely and produced a brittle joint. Titanium, however, alloyed slightly with the base and produced a strong ductile joint.

Subsequently, other brazing alloys were surveyed and five were selected for detailed investigation. These experiments were conducted by the National Research Equipment Corp. in a 4000 F cold-wall, vacuum furnace. Both Fansteel 82 and Du Pont D31 were brazed with each of the five alloys. Results are shown in Table 2.



4—Two brazed joints. *Unsuccessful joint at left was made with 90 platinum-10 rhodium alloy. Successful joint at right was made with titanium. The titanium alloyed slightly with columbium, but the platinum-rhodium eroded the base metal (20X).*

TABLE 2—BRAZING FANSTEEL 82 AND DU PONT D31 COLUMBIUM

Brazing Alloy	Brazing Temp, F	Results
Palladium	2900	Slightly dissolves base; brittle joint
Platinum	3300	Same as above
Titanium	3300	Slightly dissolves base; strong, ductile joint
90% Platinum—10% Iridium	3300	Slightly dissolves base; brittle joint
90% Platinum–10% Rhodium	3450	Severe erosion; very brittle joint

In general, test results look very promising. Of the brazing alloys being evaluated only 90 platinum–10 rhodium has been eliminated. Titanium still appears to be the best brazing alloy for columbium. Fig 4 is a micrographic comparison of a platinum-rhodium joint and a joint made with titanium.

Brazing studies are continuing with the new Martin Co. high temperature furnace, one of the largest in the country, which has an operating temperature of 4200 F.

***Temperature** of ceramic exposed to oxyacetylene flame is measured as part of program to determine thermal shock resistance and high temperature strength.*

Low Thermal Expansion + High Melting Point

=High Temperature Structural Ceramics

by F. H. Simpson, *Aero-Space Div., Boeing Airplane Co.*

■ A new family of hafnium titanate ceramics now under development combines low thermal expansion with an unusually high melting point. Thus, the materials look highly promising for high temperature structural applications.

In certain composition ranges (i.e., molar ratios of 2 to 1) the materials offer:

- Coefficients of thermal expansion ranging from –5 to 5 × 10^{-7} per °F, over a temperature range of 0-1800 F.
- A melting point of about 4000 F.

At present, maximum use temperature is limited by an apparent phase change occurring in the material at about 3400 F. Current work is aimed at modifying compositions to prevent this phase change, so that hot face use temperatures can be extended to the melting point.

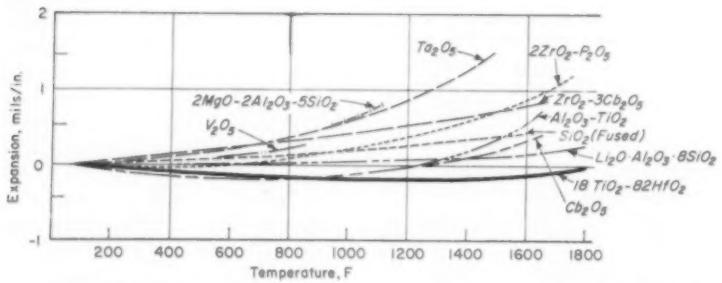
The thermal expansion characteristics of the new materials are not unique, as shown by the expansion curves for a variety of low expansion ceramics in Fig 1. However, compared with other low expansion ceramics, hafnium titanates have an exceptionally high use temperature, as shown in Table 1.

Effects of temperature on strength of three typical hafnium titanates are shown in Fig 2. Both the relatively low order of magnitude of strength, as well as the initial increase of strength with increasing temperature, are typical of low expansion ceramics in general.

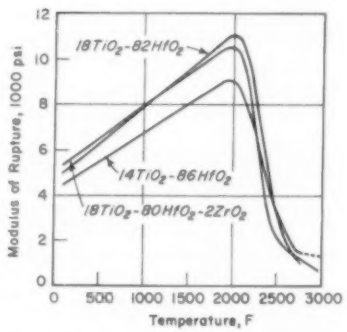
Variety of compositions

Effects of altering titania-hafnia proportions on thermal expansion are shown in Fig 3. Compositions containing from 14 to 19% titania produce the very low and negative expansions. The irregular order of the expansion of

Adapted from a paper presented at the American Ceramic Society's Pacific Coast Regional Meeting, Oct '59.



***1**—Thermal expansion of the new materials compared with that of other low expansion ceramics.*



***2**—Strength vs temperature for three typical hafnium titanates. Increase of strength with temperature to an upper critical temperature is typical of behavior of low expansion ceramic materials.*

these bodies with changing compositions is probably due to slight variations in the thermal histories of the specimens; specimens were prepared over a several months' period in different Globar furnaces. Also, specimens sintered at temperatures higher than 2750 F had slightly lower expansivities.

To determine whether expensive high purity hafnia is necessary in preparing the compositions, varying proportions of zirconia were added to the hafnium titanate bodies. Additions of zirconia were found to decrease thermal expansion, as shown in Fig 4. Density also decreases with increasing zirconia content, as would be expected due to the lower density of zirconia. Little change in porosity occurred; an addition of 2% zirconia produced the body of lowest porosity.

Table 2 shows properties of three representative bodies, one of which is the 2% zirconia body. These specimens were fired at 2200 F on a 24-hr cycle. The bars were then ground, polished and refired on a 48-hr cycle to 2800 F in a Globar kiln, the furnace being held at 2800 F for 4 hr.

Elastic moduli, calculated from

TABLE 2—PROPERTIES OF THREE TYPICAL HAFNIUM TITANATES

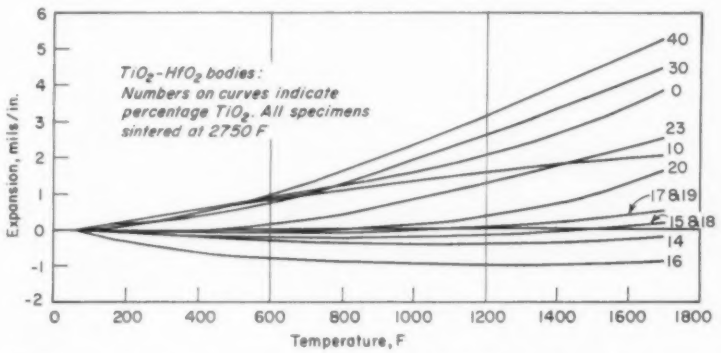
Type→	A	B	C_μ
Composition, %			
HfO_2	82	86	80
TiO_2	18	14	18
ZrO_2	....	....	2
Sintering Temperature F	2800	2800	2800
Density, lb/cu in	0.26	0.26	0.26
Apparent Porosity, %	3.91	5.0	3.8
Linear Fired Shrinkage, %	20.3	20.3	20.1
Coef of Therm Exp (80-1800 F) 10^7 per °F	2.6	−10.8	−5.4
Mod of Elast 10^6 psi	3.15	2.34	2.71
Mod of Rupture, psi			
Original (RT)	4925	4420	5280
Air Quench (5 cycles)[a]	5370[b]	3750	4600
Water Quench[a]			
1 Cycle	500	800	565
5 Cycle	500	595[c]	505

[a]Cycling from room temperature to 2500 F and back.
[b]Data from only one specimen; may not be significant.
[c]Two or three specimens broke in handling.

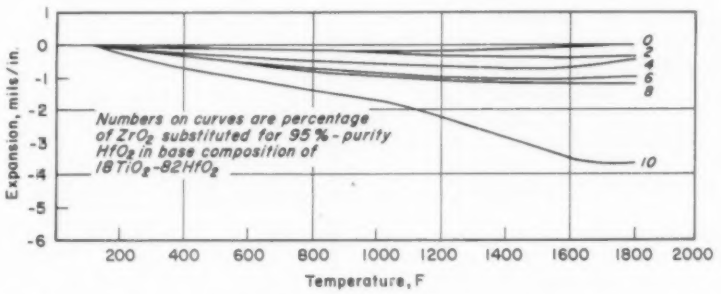
TABLE 1—COMPARATIVE THERMAL PROPERTIES OF LOW EXPANSION CERAMICS

Material	Melting Point, F	Upper Use Temp, F	Coef of Linear Ther Exp, 10^7 Per °F	Remarks
$xTiO_2 \cdot yHfO_2$	Approx 4000	3200-3400	−5 to +5 (70-1800) F)	An apparent phase change takes place near 3400 F
SiO_2 (fused)	3133[a]	1800	2.8 (70-1200 F)[b]	Devitrifies on heating above 1800 F
$xAl_2O_3 \cdot yTiO_2$	Approx 3370[c]	2150-2350[d]	−2.7 to +9.7 (70-1700 F)[e]	Dissociates if held between 2150 and 2350 F for 10 to 30 hr
$xLi_2O \cdot yAl_2O_3 \cdot 2SiO_2$	Approx 2300-2600[c]	2300	−5 to +5 (70-1100 F)	—
$ZrO_2 \cdot 3Cb_2O_5$	—	2500	5.7 (70-1600 F)[b]	—
$2ZrO_2 \cdot P_2O_5$	—	2800[f]	7.2 (70-1700 F)[f]	Dissociates slowly above 2800 F
$2MgO \cdot 2Al_2O_3 \cdot 5SiO_2$	2678[d]	2678	7.2 (70-720 F)[b]	Melts incongruently at 2678 F
Ta_2O_5	3310[g]	3310	11 (70-1450 F)[b]	—
V_2O_5	1274[h]	1274	3.5 (70-800 F)[i]	—

[a]Campbell, I. E., *High Temperature Technology*, Wiley, '56.
[b]Durbin, E. A., and Harman, C. G., *An Appraisal of Sintering Behavior and Thermal Expansion of Some Columbites*, BMI 791, Dec 15, '52.
[c]Levin, E. M., et al, *Phase Diagrams for Ceramists*, American Ceramic Soc., '56.
[d]Hummel, F. A., "Ceramics for Thermal Shock Resistance," *Newer Ceramics*, Pennsylvania State University, reprinted from *Ceramic Industry*, 1955-56.
[e]Koch, W. R., and Harman, C. G., *Aluminum Titanate as a Ceramic Material*, AECD 3213, U. S. Atomic Energy Commission, Nov 20, '50.
[f]Harrison, D. E., et al, "High-Temperature Zirconium Phosphates," *Jnl. of the Am. Ceramic Soc.*, Vol. 37, No. 6, June '54, p 277.
[g]Norton, F. N., *Refractories*, 3rd Ed., McGraw-Hill, '49.
[h]Hoelgman, C. D., *Handbook of Chemistry and Physics*, 31st Ed., Chemical Rubber Publisher Co., '49.
[i]King and Suber, "Some Properties of the Oxides of Vanadium and Their Compounds," *Jnl. of the Am. Ceramic Soc.*, Vol. 38, No. 9, Nov '55, pp 306-311.



3—*Effects of altering ratio of titania and hafnia on thermal expansion characteristics. Note very low and negative expansion compositions at bottom.*



4—*Effects on expansivity of substituting varying proportions of zirconia for hafnia in an 18 TiO_2-82 HfO_2 composition using 95% purity hafnia.*

deformation under given center-point loading on a 2-in. span, are low in comparison with those of most ceramic oxide bodies. Room temperature modulus of rupture is about that reported for lithium-aluminum-silicates and aluminum titanates.

Thermal shock resistance

Thermal shock resistance was determined by placing specimens in alundum boats, sliding them into the 2500 F hot zone of the furnace, and, after 10 min, drawing the specimens out of the furnace, and cooling either by air or water quenching. As shown in Table 2, air quenching for 5 cycles caused an approximate 13% decrease in modulus of rupture of compositions *B* and *C*. Only one specimen of composition *A* was tested, so results may not be significant.

Water quenching was definitely detrimental to the material. Little difference between one and five cycles was noted in the modulus of rupture values, but cracks appeared in the specimens after the third cycle. Sensitivity to rapid quenching is undoubtedly due to the hysteresis in expansion.

Modified Cellulose Film Has High Capacitance

Electroluminescence and microminiature capacitors are two known applications for this new dielectric. The material can be molded, too.

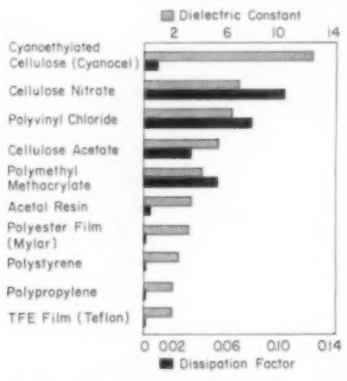
■ Newly developed cyanoethylated cellulose, trademarked Cyanocel, has the highest dielectric constant (12.5) of all known organic film-forming materials, according to its developer, American Cyanamid Co., 30 Rockefeller Plaza, New York 20. Coupled with this high K value, is a dissipation factor of less than 0.02, as shown in the accompanying bar chart. This combination provides an unusually high capacitance value—a capacitance per unit volume two to six times greater than that of comparable products, according to Cyanamid.

Transparent films have been produced in thicknesses ranging from 0.1 to 5 mils or more. The material can be cast onto any flat, smooth surface, such as glass or metal foil.

First commercial use of the material is said to be in an electro-

(more What's New on p 185)

***Clarity** of film is evident in this sample.*



***How Cyanocel compares** with other plastic film materials in dielectric constant and dissipation factor. Measurements were made at 60 cps, 110 v.*

MORE WHAT'S NEW IN MATERIALS

RCI POLYLITE Plastic Concrete Forms Cut Building Costs!

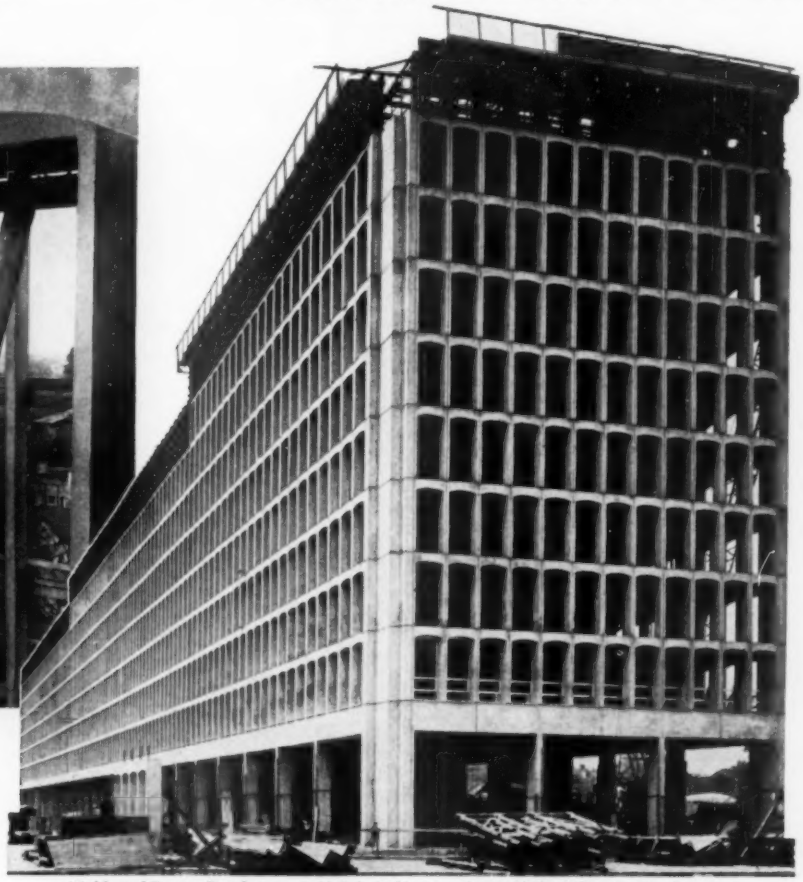
• "Reinforced plastic concrete forms made with RCI's POLYLITE polyester resin were responsible for cutting form costs by one-third in this Webb and Knapp apartment project," states Myron Austin, design engineer for Engineered Concrete Form Corporation, Chicago.

Al Schreck, carpenter superintendent for James McHugh Construction Co., Chicago, found these important advantages in reinforced plastic forms:

- They can be adapted to virtually any shape.
- They have greater strength to withstand the impact stresses of cement pours; flexural strength is about 30,000 psi.
- Light in weight, about half that of a lumber form, they can be handled and erected more economically.
- Highly resistant to abrasion, they can be used over and over again.
- Low expansion/contraction properties of reinforced plastic forms, when exposed to heat and cold, provide a high degree of dimensional accuracy in the cured concrete.
- The smooth plastic surface of the forms provide the trowelled-like finish of a skilled concrete artisan, without extra cost.

This is only one example of how plastics are improving on old techniques. If you have an application which might be simplified or improved by the use of reinforced polyester, it will pay you to call on RCI.

Part of the Webb and Knapp apartment project in Chicago which contains 4,500 arched windows poured in POLYLITE plastic forms; and close-up of one of the POLYLITE forms. With proper handling, forms can be used 50 to 100 times.



Webb and Knapp, Developer — I. M. Pei, Architects — James McHugh Construction Company, Concrete Subcontractor — Engineered Concrete Form Corporation, Form Manufacturer

Creative Chemistry ... Your Partner in Progress RCI

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REICHHOLD CHEMICALS, INC., RCI BUILDING, WHITE PLAINS, N.Y.

For more information, turn to Reader Service card, circle No. 431

Publicly available property data

To the Editor:

We are a small manufacturer of gas-fired heating equipment, and have recently developed an infrared, overhead heat fixture for industrial plants. We are using type 430 stainless steel in a thoroughly oxidized surface condition at 1000 F as our emitter.

Some large potential buyers have asked us about the emissivity of type 430 at the conditions described above. We have not been able to get the information from any steel company. However, one company advised that the emissivity of type 430 should be close to that of type 302 stainless steel. It said that an emissivity of 0.78 to 0.80 has been observed for type 302 under the named conditions.

Many of the larger concerns working on infrared have undoubtedly developed this type of information, probably at government expense, and do not release it when asked by smaller concerns such as ourselves.

We think that a table of emissivities and reflectivities of engineering materials at various temperatures would be extremely helpful to small manufacturers in building new and useful equipment.

In our free enterprise system, we sincerely believe that information which is useful to industry should be publicly available . . .

WILLIAM P. HORNE
Bright Leaf Industries, Inc.
Charlotte, N. C.

Properties of gray iron castings

To the Editor:

In the Feb '60 issue of your magazine there appeared an article by R. C. Bates entitled "How Section Size Affects Gray Iron Castings" (p 100). I read the article carefully as I am interested in this field.

I have written a paper which describes a new procedure for predicting mechanical properties of gray iron castings based on chemical composition and thickness of the part.

The procedure is based on the assumption that mechanical properties can be considered to be related by the following factor:

$$K = \frac{4.3 - C}{Si}$$

where C and Si are percentages of carbon and silicon, respectively.

Tensile strength is related to thickness of a plate by the following formula:

$$\sigma = \frac{9.1\ (1 + K\sqrt{e})}{\sqrt{e} - K}$$

where σ is tensile strength in kg per sq m and e is thickness of the plate in cm.

Thickness of the plate is related to test bar diameters by a factor that is approximately two but

varies slightly with diameter.

By checking the above formula against various test results, I found good agreement with test bars cast to size and test bars taken from actual parts.

However, I was surprised when I found discrepancies in my formula if values in Fig 3 for Class 30 castings are compared against the formula. I am assuming that the chemical composition given on p 102 for Class 30 castings is an average figure, but differences in composition are quite important for small and large test bar diameters.

My formula checks very well with average test bar diameters, but values are too small for larger diameters and too large for smaller diameters.

Values given in Fig 2 for Class 20 castings check very well with my formula, so I assume that chemical composition does not differ much in this case from the average. Fig 4, 5, 6 and 7 in the article cannot be compared against my formula because they are related to alloyed cast irons which are not taken into account in my formula.

EDUARDO ABRIL
Chief Metallurgist
Industria Kaiser Argentina S. A.
Cordoba, Argentina

A copy of Mr. Abril's letter has been forwarded to author Bates.

High energy rate forming processes

To the Editor:

I have read the very interesting article on "High Energy Rate Forming Processes," and am wondering how I can get further information on powder compacting as mentioned on p 92 of your July issue.

Specifically, I would like to know as much as possible about the studies conducted at China Lake Naval Ordnance Test Station on explosive powder compacting to form neutron absorbers.

JOHN CALDWELL
Research Analyst
Atomics International
Canoga Park, Calif.

Information has been forwarded.

Kudos for filament winding article

To the Editor:

You deserve an accolade from all of us in the filament winding business for the excellent job of assembling and presenting information on filament winding (M/DE, Aug '60, p 127).

F. C. CRYMES
Manager
Commercial Spiralloy Sales
Hercules Powder Co.
Wilmington, Del.

WIN CASH—Each month $10 will be paid for the best letter written to an author (through us), an editor, or addressed to this column. We reserve the right to withhold awards.

Announcing the SECOND Bachner Award COMPETITION

for outstanding achievement in the use of plastics

BACHNER AWARD TROPHY

The Bachner Award is conferred for excellence in the practical application of molded and formed plastic materials to the products of industry.

The Award was established in 1957 by the CHICAGO MOLDED PRODUCTS CORPORATION. It was named to honor the Company's founders for their contributions to the progress of the plastics industry.

The company winning the Second Bachner Award Competition will receive the trophy, suitably inscribed, and the individual(s) designated by the company as being most responsible for the achievement will receive $1,000. There is also provision for Honorable Mention Citations. Entries must be received by March 6, 1961. Awards will be made at the time of the National Plastics Exposition in New York in June 1961.

Complete information and entry forms are obtainable from the Secretary to the Committee, Mr. William T. Cruse, c/o Society of the Plastics Industry, Inc., 250 Park Avenue, New York 17, N.Y.

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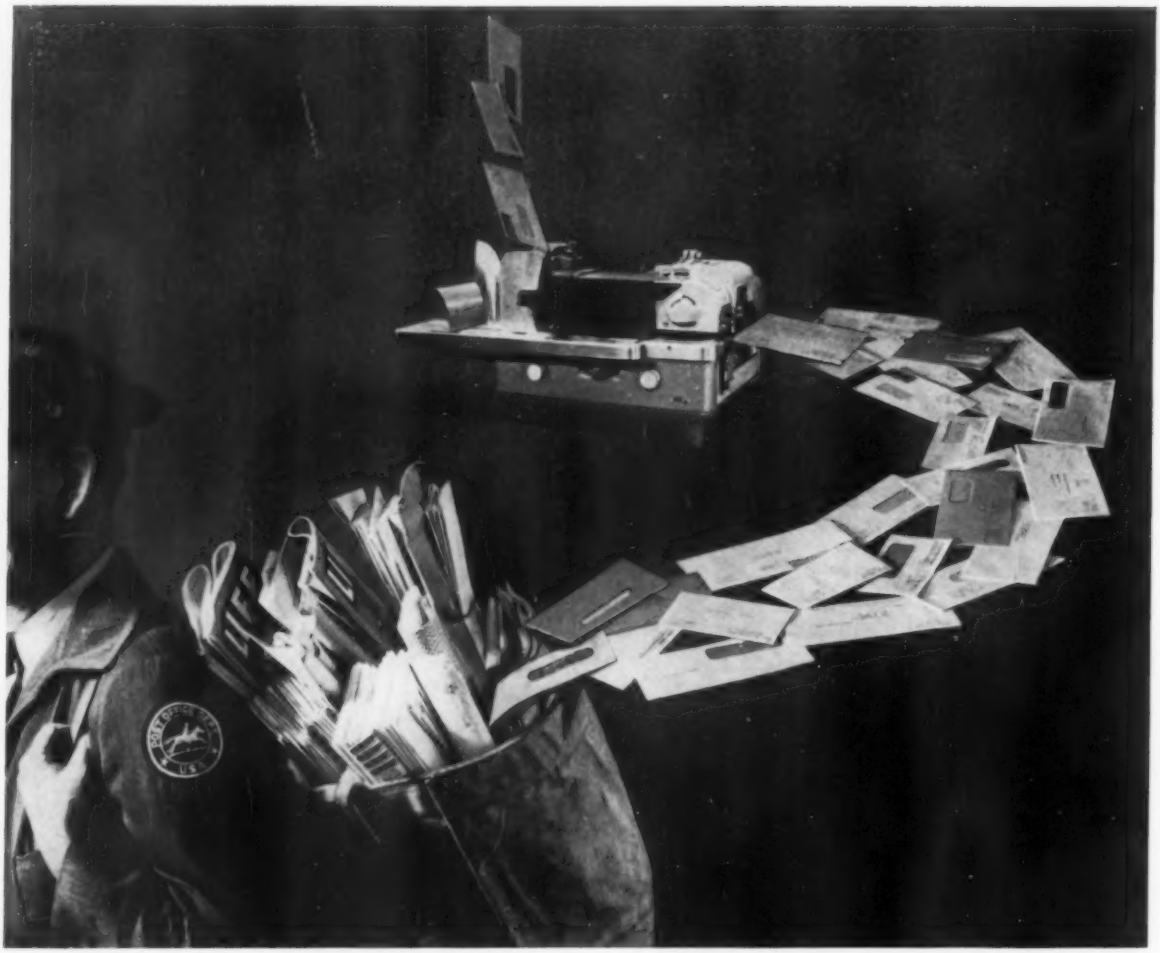

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PRICES & SUPPLY

...AT A GLANCE

Price cuts on stainless steel finished mill products have been announced by Allegheny Ludlum Steel Corp., Crucible Steel Co. of America, Universal Cyclops Steel Corp. and United States Steel Corp. The reductions, applicable to types 304 and 304L, range from 2½ to 3¢ per lb. Products affected by the price cut are sheets, cold rolled strip, bars and structurals, and hot rolled rods, wire and forging billets. In addition, U. S. Steel says it has reduced prices on raw and semifinished types 304 and 304L in ingot and slab form. Plate prices have not been reduced.

Steel imports totaled 1.4 million tons in the first quarter of this year—85% above the 758,000 tons imported during the same period in 1959, says the American Iron and Steel Inst. Despite a decline in domestic steel output, sheet and strip imports soared to 247,000 tons, or 16 times the total for the first quarter of 1959.

Sharp increases in the demand for polycarbonate resins were predicted for the next decade by A. E. Schubert, general manager of GE's Chemical Materials Dept., at the opening of the firm's new polycarbonate plant in Mt. Vernon, Ind. Schubert says the market for polycarbonates should climb to about 30-50 million pounds within five years and reach 75-100 million pounds by 1970. The new GE plant can initially produce more than five million pounds of polycarbonate resins annually.

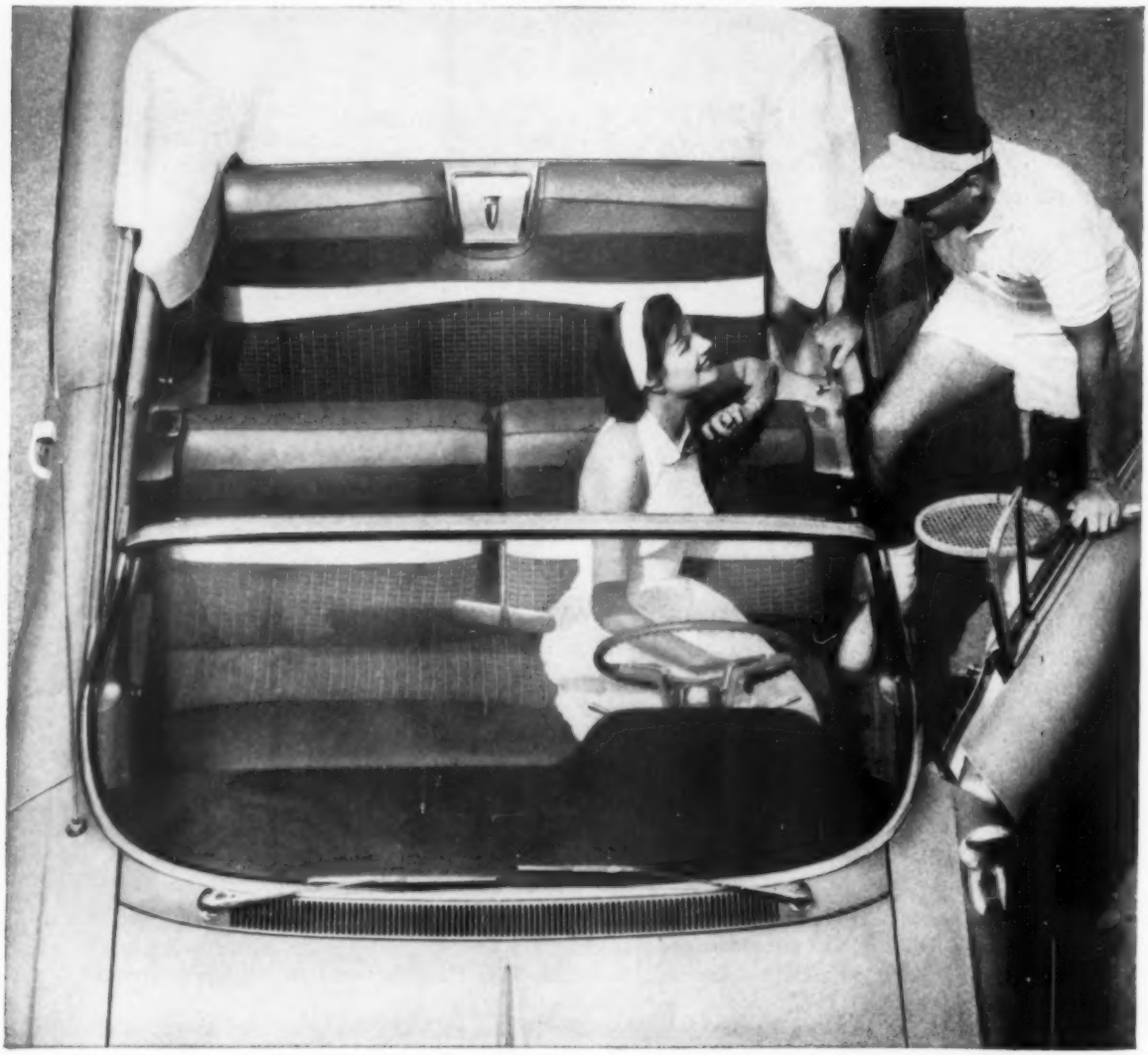
Price cuts on low density polyethylene resins and compounds have been announced by the major polyethylene producers following an initial price slash by Union Carbide Plastics Co. Basic price for Carbide's low density polyethylene is now 27½¢ per lb in truckload lots, down 5¢ per lb.

Production of polyethylene is being doubled at National Distillers' U.S.I. Div. plant at Houston, Tex. This latest expansion brings U.S.I.'s total production capacity of Petrothene low and medium density resins to 300 million pounds per year.

Price of fused quartz yarn and roving has been cut by General Electric Co. The new prices are $35 per lb for yarn and $29 to $32 per lb for roving. Previous price for the two forms was $65 per lb. Recent tests show that quartz thread and cloth withstand temperatures over 5000 F (M/DE, Feb '59, p 123).

More nickel will be available when International Nickel Co.'s new mining operation at Thompson, Manitoba comes into full scale production in 1961 at an annual rate of 75,000,000 lb. The Thompson project is said to be the second largest nickel-producing operation in the world. At the same time, nickel supplies in this country are said to be more than adequate despite the shutdown of Freeport Nickel Co.'s facilities and the uncertainties surrounding the U. S. government's Nicaro plant in Cuba.

Price of a new high temperature urethane foam system called PAPI (polymethylene polyphenyl-isocyanate) has been reduced to $1.50 per lb in drum lots. Previous price was $2.25 per lb. The material was described in M/DE, July '60, p 11.



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First Die Casting Show Set for Detroit, Nov 8-11

The first National Die Casting Exposition and Technical Congress has been scheduled for Nov 8-11 at the Detroit Artillery Armory.

The exposition, sponsored by the Society of Die Casting Engineers, is said to be the first show in this country devoted exclusively to the die casting field.

Process widely used

In announcing the new exposition, John C. MacLaren, chairman, pointed out that total die casting metal consumption in 1957 was over 600,000 tons, or more than twice that of 1947.

"It is this explosive growth," he said, that led the Society to sponsor the 1960 exposition.

Exhibitors at the show will include independent and semi-captive die casters, suppliers of die casting equipment, producers of metals and alloys and design services.

Topics based on survey

The Technical Congress, designed to present the latest developments and trends in the die casting field, will also be sponsored by the Society. Subjects have been selected on the basis of an industry survey of specific interests in the die casting field. Topics include: metallurgical developments; die design; die building; what's ahead in die casting; competition to die casting; cost and profit; quality control; vacuum die casting; anodizable die castings; die steels, buffing, polishing and plating of die castings; zinc, magnesium and brass die casting techniques; lubricants; handling and treating of metals; standards; large die castings; and die casting alloys.

For further information, contact the Society of Die Casting Engineers, 19382 James Couzens Hwy., Detroit 23.

Air Force to Study Welding of Refractory Metals

Three new materials research and development programs have been initiated by branches of the armed services.

Two of the contracts, awarded by the Air Force, involve development of 1) improved types of beryllium, and 2) methods of welding molybdenum and tungsten by electron beams. The third contract, awarded by the Navy, is aimed at the development of molybdenum alloy sheet.

Fabricable beryllium

The beryllium project, awarded to Nuclear Materials and Equipment Corp., will concentrate on the development of fabricable beryllium for use in missiles and aircraft. Although beryllium is the lightest metal and has great potential in these applications, it has not as yet been made available with sufficient ductility to be used in significant quantities for these purposes. The objective of the contract is to overcome this problem.

Welding tungsten and molybdenum

Also concerned with missiles and space vehicles will be Hamilton-Standard Div., United Aircraft Corp., which will be studying ways and means of welding tungsten and molybdenum with the electron beam process.

Both molybdenum and tungsten are difficult to weld by normal techniques. Under high welding heats (5000 to 6000 F) they tend to become brittle, and unless heat is confined to the immediate weld area there is a serious loss of the metal's strength.

In the electron beam process, according to Hamilton-Standard, the heat-affected zone can be reduced to an extremely small area —in some cases to a spot less than 0.001 in. in dia.

In its study program, Hamilton-Standard will first produce butt, lap, seam, edge and spot welds in sheets of molybdenum and tungsten ranging in thickness from 0.005 to 0.10 in. It will then study the effects on weld quality of variations in machine settings. And, finally, it will evaluate welded pieces to determine weld quality

METAL SHOW—See pp 47-55 for details on registration, technical program and exhibitors at the 42nd National Metal Congress and Exposition, Oct 17-21, in Philadelphia.

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and microstructure, size of heat-affected zones, ductility of welded areas, and tensile strengths of samples exposed to temperatures as high as 2200 F for molybdenum and 2800 F for tungsten.

Molybdenum alloy sheet

The third project, awarded to Universal-Cyclops Steel Corp., will involve process development in the production of molybdenum alloy sheet. Two alloys will be investigated: molybdenum-0.5% titanium and molybdenum-0.5% titanium-0.07% zirconium.

Specifically, the program is designed to produce optimum conditions of isotropy, homogeneity, and reproducibility. Variables to be studied are: 1) single vs double vacuum arc melting, and 2) the following four methods of processing molybdenum ingot to plate: extrusion of alloys to rounds and then forging them to sheet bar; direct extrusion to sheet bar; extrusion in air with subsequent forging in Universal-Cyclops' In-Fab (inert atmosphere fabrication); and direct forging in In-Fab.

Uses of Magnesium Is Cleveland Topic, Oct 17

"Blueprint for Magnesium" is the theme around which the Magnesium Assn. will hold its 16th annual convention.

Set for Oct 17-19 at the Pick-Carter Hotel, Cleveland, the convention will concentrate on "those applications of magnesium which hold the greatest promise as major potential markets in the next few years."

Technical discussions at the meeting will cover such topics as: thin section, high integrity permanent mold castings by the centrifuge method; magnesium alloys in missiles and satellites; chemical milling of magnesium; successful use and control of emissivity finishes on HK31A magnesium for thermal design; and corrosion protection of magnesium in electronic equipment.

Three other meetings set for October

In addition to the magnesium meeting and the Metals Show (see pp 47-55), three other groups will sponsor meetings on materials and materials problems this month.

Plastics and rubber—The Rubber and Plastics Div. of the American Society of Mechanical Engineers will hold its first annual conference in Erie, Pa. on Oct 9-11.

Papers at the conference will be divided into four basic categories: vibration and shock control; bonding of engineering structures; nonrigid structures; and automation of rubber and plastics processing.

Papers of particular interest include: design strength data and calculation for long-term use of thermoplastics; novel design in sandwich structures; new apparatus for study of mechanical and electrical properties of plastics; and reinforced plastics films.

Space age materials—A one-day symposium on Materials and Processes for Use in the Space Age has been arranged by the Delaware Chapter of the Society of Aerospace Materials and Process Engineers (SAMPE) for Oct 24 at the Bellevue-Stratford Hotel, Philadelphia.

Specific subjects to be covered at the symposium include: a new approach to vacuum bag molding of glass cloth laminates; development and formulation of experimental diisocyanate-based resins for structural laminates; urethane foams for aerospace applications; fluorescent coatings for improved visibility; and application of thick coatings to re-entry vehicles.

Tool seminars—High energy rate forming is the subject of the first of a series of ten technical seminars to be sponsored by the American Society of Tool and Manufacturing Engineers.

The seminar, scheduled for Oct 11-12 at Chicago's Sheraton Towers, will cover design, materials, reliability, forging, extrusion, explosives, hydro-spark, shock waves, and tooling requirements.

Registration fee is $45 for members and $60 for nonmembers.

The series of ten seminars will be held in various industrial areas around the country and will cover standards and standardization, metal cutting, quality control, machining and forming space age materials, plastics tooling, automation and numerical control, die and design, and process planning–operations research.

Additional information can be obtained from ASTME Headquarters, 10700 Puritan Ave., Detroit

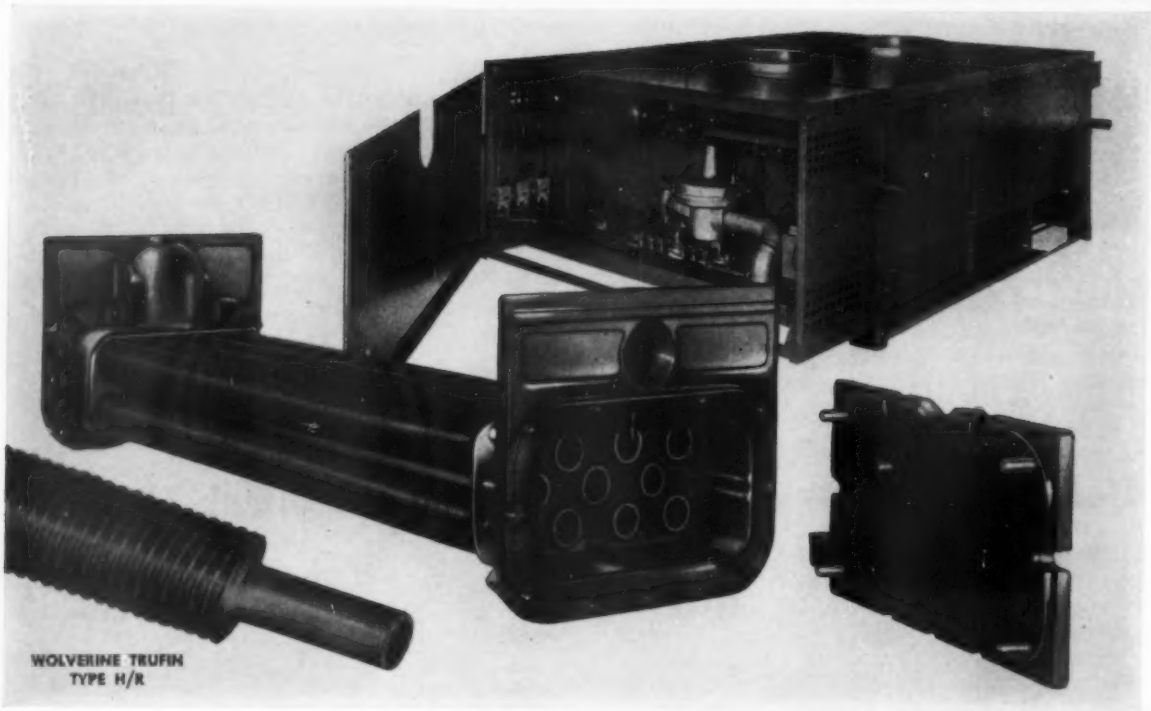
Symposium on Basic Science

A special symposium on Basic Science in France and the United States has been arranged by New York University for Oct 17-19.

The symposium, sponsored by NYU in cooperation with the French Government and supported by a $10,000 grant from the Alfred P. Sloan Foundation, will be held at NYU's Loeb Student Center at Washington Square South. Six French scientists will discuss their fields at general meetings, and six American scientists will join them in panel sessions.

Topics to be discussed include: metal physics, magnetic resonance, hydraulics, astronomy, geology, and science administration.

Coming Meetings on p 31 ⟶



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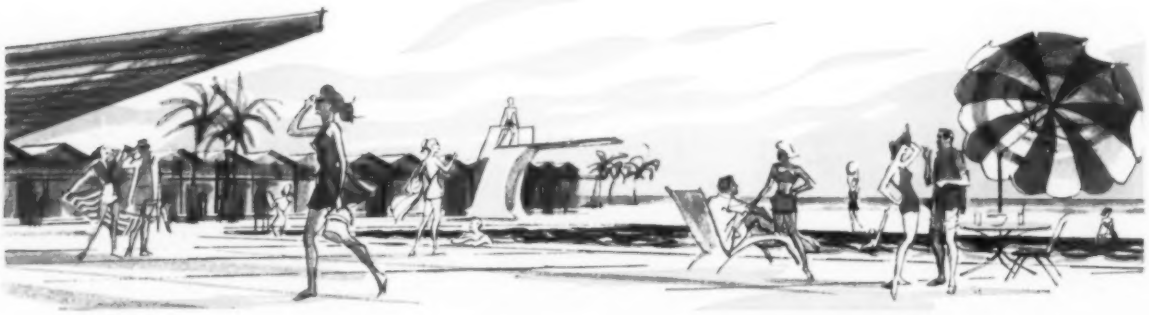

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News OF INDUSTRY

Coming Meetings

PRESSED METAL INSTITUTE, annual meeting. Shawnee-on-the-Delaware, Pa. Oct 10-14.

GRAY IRON FOUNDERS' SOCIETY, INC., 32nd annual meeting. Cincinnati. Oct 12-14.

NON-FERROUS FOUNDERS' SOCIETY, annual meeting. Asheville, N. C. Oct 13-15.

SOCIETY OF THE PLASTICS INDUSTRY, INC., 16th annual New England Section Conference. Portsmouth, N. H. Oct 13-14.

MAGNESIUM ASSN., annual convention. Cleveland. Oct 17-18.

15TH PLASTICS-PAPER CONFERENCE, Technical Assn. of the Pulp and Paper Industry. Syracuse. Oct 17-19.

SOCIETY FOR NONDESTRUCTIVE TESTING, annual meeting. Philadelphia. Oct 17-21.

42ND NATIONAL METAL EXPOSITION AND CONGRESS, American Society for Metals. Philadelphia. Oct 17-21.

METALLURGICAL SOCIETY, American Institute of Mining, Metallurgical and Petroleum Engineers, fall meeting. Philadelphia. Oct 17-21.

SOCIETY OF PLASTICS ENGINEERS, New York Section Conference. New York City. Oct 19.

NATIONAL ASSN. OF CORROSION ENGINEERS, 5th annual north central regional conference. Milwaukee. Oct 19-20.

NATIONAL TOOL AND DIE MFRS. ASSN., annual meeting. Minneapolis. Oct 19-23.

AMERICAN HOT DIP GALVANIZERS ASSN., semi-annual meeting. White Sulphur Springs, W. Va. Oct 24-25.

GALVANIZERS COMMITTEE, American Zinc Institute, Inc., 42nd annual meeting. Canton, Ohio. Oct 27-28.

FEDERATION OF SOCIETIES FOR PAINT TECHNOLOGY, 24th annual meeting. Chicago. Oct 29-Nov 2.

SOCIETY OF PLASTICS ENGINEERS, Ontario Section regional conference. Ontario, Canada. Nov. 7.

1ST NATIONAL DIE CASTING EXPOSITION AND CONGRESS, Society of Die Casting Engineers. Detroit. Nov 8-11.

WESTERN TOOL SHOW, American Society of Tool and Mfg. Engineers. Los Angeles. Nov 14-18.

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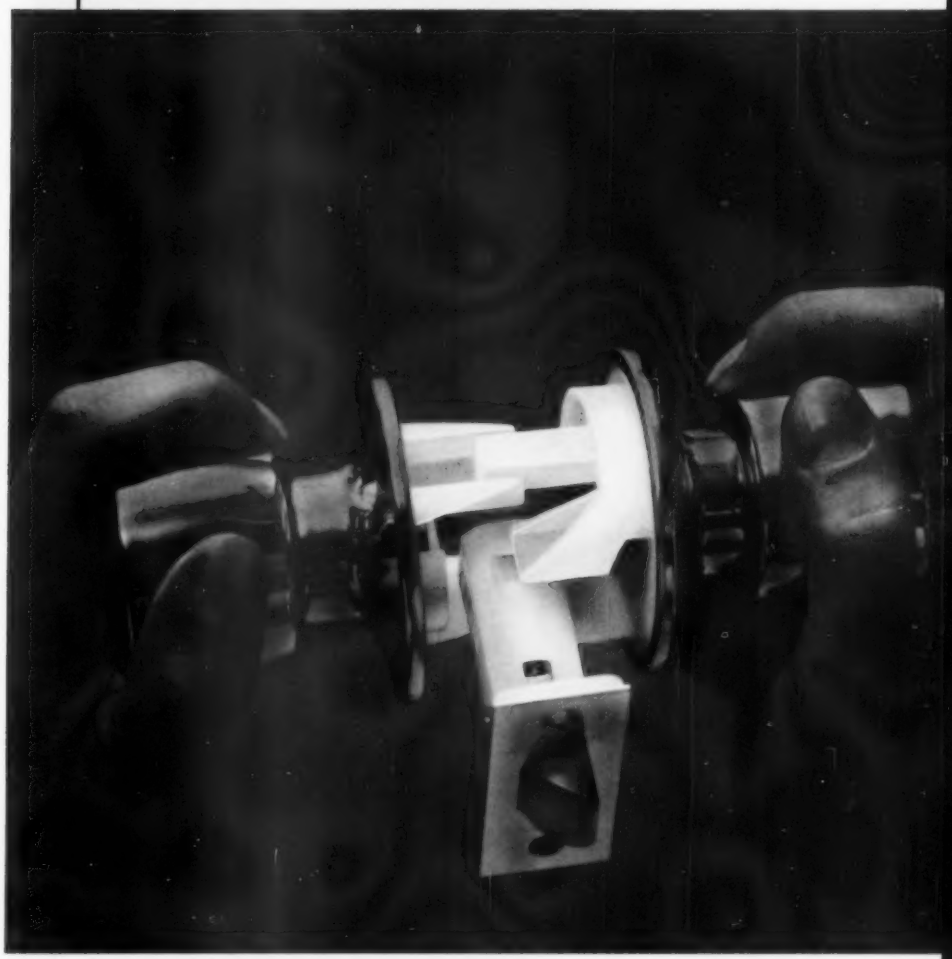

New lockset designed with ZYTEL® offers easy installation...lifetime service...economical production

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In short, it took Du Pont ZYTEL nylon resin.

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On the following page, you will find further illustrations of the design improvements and cost reductions made possible by the complete line of ZYTEL nylon resins.

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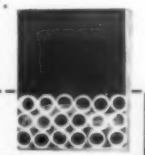

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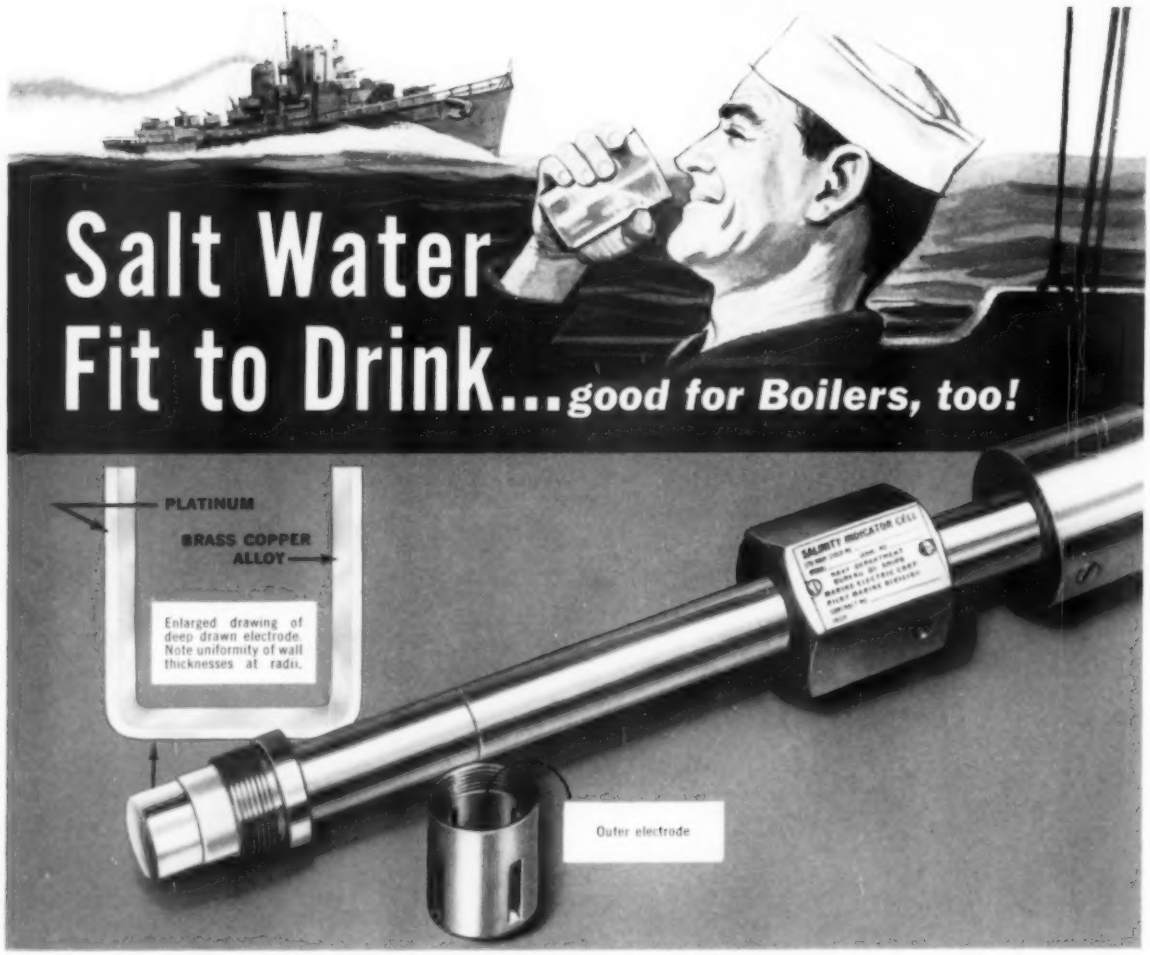

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Large tungsten ingots	198	621
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Modified cellulose film has high capacitance	18	611
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Suppliers' New Bulletins

Hardenable Cast Stainless Alloy. Alloy Casting Institute, 6 pp, illus. Composition, room temperature properties, corrosion resistance, weldability, typical applications and other information on a hardenable cast stainless steel alloy. **1**

Shaped Wire Catalog. Page Steel & Wire Div., American Chain & Cable Co., Inc., 16 pp, illus., No. DH-1226-A. Information on various analyses of wire preshaped to a desired cross-section. Included is information on methods of calculating areas of common shapes; physical properties of steel wire; a table of standard wire gages; and hardness conversion tables. **2**

Custom Plastics Extrusion. Anchor Plastics Co., Inc., 72 pp, illus., No. AP60-RM. Several articles cover the design and application of plastics extrusion, including information on the facilities available from this company. Also covered are property tables, short descriptions of materials, and more than 700 cross-sectional diagrams of typical plastics extrusions. **3**

Nickel-Plated Steel. Apollo Metal Works, 8 pp, illus. Information on the fabricating characteristics of nickel-plated steel. **4**

Porous Bronze, Iron Bearings. Bound Brook Oil-Less Bearing Co., 36 pp, illus. Comprehensive list of sizes and types of porous bronze and porous iron bearings and washers. **5**

Integrally Finned Tubing. Wolverine Tube Div., Calumet & Hecla, Inc., 4 pp, illus. General description, sizes and materials available, and typical uses of integrally finned tubing. **6**

Custom Ceramic Parts. CFI Corp., 4 pp, illus., No. 958. Information on ceramic components, ceramic-to-metal seals, glass-to-metal seals, and special ceramic compositions. **7**

Castable Ceramic Fiber. Carborundum Co., Research & Development Div., 3 pp. Properties, casting procedures, prices, and suggested uses of a castable ceramic fiber. **8**

Stainless Steel Services. G. O. Carlson, Inc., 12 pp, illus. Information on stainless steel plates, heads, forgings, rings, circles, flanges, bars, and sheets used in the metalworking, chemical process, nuclear, and aircraft and missile industries. **9**

High Density Polyethylene. Celanese Polymer Co. Div., Celanese Corp. of America, 10 pp, illus., No. P2A. Series of typical applications show the advantages of high density polyethylene for such things as toys and sporting goods, housewares, bottles, containers and closures, textile applications, industrial applications and film. **10**

Vinyl Plastisols. Chemical Products Corp., 12 pp, illus., No. 144. Chemical and physical characteristics, advantages, and typical uses of vinyl plastisols applied by dipping, casting, low pressure forming, wiping, spraying, and spreader coating. **11**

Stainless Steel Tubing. Columbia Steel & Shafting Co., Summerill Stainless Tube Div., 4 pp, illus., No. 7247. Analyses, tolerances, specifications, sizes and other information on a line of stainless steel tubing. **12**

Beryllia Ceramics. Coors Porcelain Co., 2 pp, illus. Property chart lists mechanical, physical, electrical and other properties of two beryllia ceramic compositions. **13**

Magnesium Finishing. Dow Metal Products Co., 8 pp, illus., No. 143-267. Article discusses principles of corrosion and how to protect magnesium and its alloys. **14**

Silicone Dielectric. Dow Corning Corp., 4 pp, illus., No. 4-218. Information on how silicone protects pole line insulators and electrical equipment bushings against excessive leakage, flashovers, and service interruptions in areas where atmospheres are contaminated by salt spray, industrial dust, and other airborne particles. **15**

Acetal Plastics. E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., 6 pp, illus., No. A-7547. General information, advantages, typical applications, and prices of acetal plastics compared with other materials. Included is a discussion of coating acetal on metal. **16**

TFE Fluorocarbon. E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., 8 pp, illus., No. A-12544. Advantages; characteristics; and mechanical, physical, electrical and other properties of TFE fluorocarbon wire and cable, electrical components, seals and rings, bearings, hose, lined pipe, gaskets and packings, nonstick surfaces, and standard shapes. **17**

Nylon Resins. E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., 4 pp, illus, No. A-14023. Three case histories point out advantages and uses of nylon resins. Included are some design tips on methods of assembly for molded nylon parts. **18**

Metal Powder Parts. Eaton Mfg. Co., 8 pp, illus., Vol. 18, No. 2. Article discusses metal powder parts in general, several methods of producing them, equipment and facilities required, heat treatment of iron powder parts, and mechanical properties of various iron powders. **19**

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Nickel-Chromium Resistance Alloy. Hoskins Mfg. Co., 8 pp, illus., No. 110. Compositon; physical, mechanical, and electrical properties; temperature-resistance curves, and other technical data on a new modified 80-20 nickel-chromium resistance alloy developed for use as heating elements in controlled atmosphere furnaces. **24**

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zinc, cadmium and aluminum conversion coatings. **25**

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High Strength Steel Bar. La Salle Steel Co., 4 pp, illus. Information on how high strength, easy-to-machine steel bars can be used for making a wide variety of parts such as shafts, pins, gears, pinions, nuts, etc. **27**

Steel Plate Shapes. Lukens Steel Co., 16 pp, illus., No. 378. Information on facilities available for flame cutting, shearing, blanking, punching, pressing, bending, and welding various shapes made from steel plates. **28**

Tin News. Malayan Tin Bureau, 8 pp, illus., May '60. Monthly, publication covers new alloys, production and consumption figures, applications of tin and its alloys, meetings of the International Tin Council, and other items of interest concerning tin. **29**

Nodular Iron Castings. Meehanite Metal Corp., 714 North Ave., New Rochelle, N. Y., 8 pp, illus., No. 47. Advantages, specifications, properties, characteristics, and typical uses of five types of nodular iron castings. Write on company letterhead directly to Meehanite.

Heat Reactive Vinyl Tubing. Minnesota Mining & Mfg. Co., Irvington Div., 4 pp, illus. General information, technical data, and dimensions of heat reactive vinyl tubing used in covering for harness cables, condenser coils, bus bars, transformer leads, high voltage leads, and others. **30**

Coiled Vinyl-Metal Laminates. National Steel Corp., Enamelstrip Corp. Div., 8 pp, illus., No. 201-10-088. Advantages, typical applications, and other information on vinyl-metal laminates in coiled form. **31**

Friction Materials. Raybestos-Manhattan, Inc., Equipment Sales Div., 48 pp, illus., No. 501. Advantages, characteristics, uses, and properties of various types of friction materials used for brake linings, clutch facings, and other friction parts. Included are discussions of woven and molded asbestos, semi-metallic types, sintered metal types, and other special types. **32**

Epoxy Resin. Ren Plastics, Inc., 12 pp. Advantages, characteristics, and typical industrial applications of epoxy resins. **33**

Gold Electroplate Thickness. Sel-Rex Corp., 5 pp, illus. Latest techniques for controlling and measuring thickness and hardness of precious metal electroplates, with particular emphasis on gold. **34**

Polyvinyls. Shawinigan Resins Corp., 8 pp, illus. Properties, uses, and other information on a line of resins, coatings, adhesives, emulsions dispersions, etc. made from polyvinyl acetate, polyvinyl acetate copolymers, polyvinyl alcohol and polyvinyl butyral. **35**

Polystyrene. Shell Chemical Corp., 2 pp, No. SC-60-100. Information on facilities and services available for the production of polystyrene compounds for molding, extruding, and vacuum forming. **36**

Tubing for Aircraft, Missiles. Superior Tube Co., 12 pp, illus., No. 372. Information on various types of tubing used for fluid handling lines, jet engine components, heat exchangers, rocket engines, pressure gages, airframe ducting, pneumatic systems, structural parts, etc. Included is information on the tubing characteristics required for specific applications. **37**

Glass-Epoxy Molded Channels. Swedlow, Inc., 4 pp, illus., Sect. 8-D. Article discusses the use of high strength glass-reinforced epoxy channels used to thermally insulate the cabin floor of the DC-8 airplane. **38**

Wire, Rod and Strip. Techalloy Co., Inc., 44 pp, No. 14. Chemical, physical and mechanical properties; and prices of monel, nickel, nickel-clad copper, Inconel, Inconel X, Incoloy, Nionel, stainless and heat resisting steels, electrical resistance alloys, glass sealing alloys, and other metals in the form of wire, rod and strip. **39**

TFE Fluorocarbon. U. S. Ceramic Tile Co., Sparta Mfg. Co. Div., 6 pp, illus., No SM-100. Facilities available for the production of standard molded and machined TFE fluorocarbon shapes. Included is a property chart and some typical examples of various shapes available. **40**

Vanadium Catalysts. Vanadium Corp. of America, looseleaf. Bibliography of references to vanadium catalysts, for the years 1940 to 1954, covers reaction descriptions, catalyst employed in each case, and the names of the observer and source publication. **41**

Colored Stainless Steel. Washington Steel Corp., 8 pp, illus., No. B-59-3. Information on a coating process that applies uniform color finishes on stainless steel sheet and strip. Included are discussions of color range, advantages, characteristics, typical uses, and results of various tests. **42**

Super Alloy Forgings. Wyman-Gordon, 4 pp, illus. Composition, heat treatment, mechanical and physical properties, typical applications, materials used, and other information on superalloy forgings. **43**

Other Available Bulletins

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Aircraft Steels. Allegheny Ludlum Steel Corp., 24 pp. Mechanical and physical properties at various temperatures, heat treating and fabrication data, and applications of AM-350 and AM-355 precipitation hardening aircraft steels. **44**

Stainless Steel Parts. Alloy Products Corp., 20 pp, illus. Information on drawn and welded stainless steel shapes. **45**

Ferrous Alloy Castings. American Manganese Steel Div., American Brake Shoe Co., 8 pp, illus., No. S-57. Properties of alloy steel and iron castings. **46**

Small Diameter Tubing. J. Bishop & Co. Platinum Works, 24 pp, illus. Properties, availability and uses of small stainless steel tubing. Also covered is the use of clad metals and composite wires in the instrument, missile and electronic fields. **47**

Steel Forgings. Cameron Iron Works, Inc., Special Products Div., 44 pp, illus. Dimensions and weights of various shapes and forms forged of stainless and alloy steel. Shows how forgings are made. **48**

Steel Wire. Continental Steel Corp., 12 pp, illus. Information on standard and special-shaped wire, coarse round wire, and fine and specialty wire made of low and medium carbon steels. **49**

Stainless Steels. Cooper Alloy Corp., 10 pp, illus. Composition ranges, mechanical properties, corrosion resistance and high temperature mechanical properties of molybdenum-containing 18-8 type stainless steels. **50**

Steel Tubing Catalogue. Copperweld Steel Co., Ohio Seamless Tube Div., 8 pp, illus., No. CS-60. General information, specifications, tolerances, fabrication data and uses of carbon and alloy steel seamless tubing and carbon steel electric welded steel tubing. **51**

Steel Castings. Dodge Steel Co., 20 pp, illus., No. DS-1155. Advantages, properties, heat treatment, and selection factors for steel castings **52**

High Alloy Castings. Duraloy Co., 20 pp, illus., No. G-159. Physical properties of corrosion resistant, heat resistant and abrasion resistant high alloys used for static, centrifugal and shell molded castings. **53**

Stainless Steel. Eastern Stainless Steel Corp., 4 pp, illus. Describes Type 321 SW grade of sheet and plate resulting from new method of melting ingots. **54**

Rolled Steel Rings. Edgewater Steel Co., 12 pp, illus. Describes and illustrates a process by which rolled steel rings are formed from solid blocks. **55**

Properties of Stainless Steels. Peter A. Frasse & Co., Inc., Sect. A, No. 4. Data chart provides a comparison of properties for 18 different grades of stainless steel. **56**

Perforated Metal Sheets. Harrington & King Perforating Co., Inc., 6 pp, illus. Sizes, gages and materials of perforated metal sheets carried in stock. **57**

Metal Fabrication. Jervis Corp., 16 pp, illus. General description of facilities and services available from this company which include stamping, casting, assembly, machining, welding, and finishing of parts used in the automotive, marine, residential building, aircraft and missiles, and appliance industries. **58**

Spring Steels. National-Standard Co., Athenia Steel Plant, 28 pp, illus., No. 579. Facilities for producing cold-rolled high carbon flat spring steels. **59**

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Stainless Wire. Universal-Cyclops Steel Corp., 4 pp, illus., No. SS-200. Information on cost, corrosion resistance and cold heading characteristics of commonly used stainless steel cold heading wire. **65**

Nonferrous Metals • Parts • Forms

Aluminum Ingot Products. Aluminum Limited Sales, Inc., 58 pp, illus. Information on aluminum casting, alloying, and various types of ingots; typical properties and characteristics of sand, permanent mold, and die casting alloy; heat treatment; forms and sizes; typical mechanical properties and characteristics of wrought alloys; and other engineering data on aluminum ingot products. **67**

Fabricated Metal Products. American Brass Co., Fabricated Metal Goods Div., 8 pp, illus., No. BG-5. Information on fabricated metal products made of copper, brass, bronze, nickel silver, iron, steel, stainless steel and aluminum. **68**

Metal Powders. Metals Disintegrating Co., Div. of American Marietta Co., illus. Description, specifications, properties and uses for all types of metal powders. **69**

Sulfur Copper Alloy. American Metal Climax Inc., Amco Div., 8 pp, illus., No. C-17. General information, advantages, mechanical and physical properties, annealing and drawing characteristics, and typical applications of a sulfur copper alloy. **70**

Extruded Aluminum Bronze. Ampco Metal, Inc., 4 pp, illus., No. G-50a. Sizes, weights, physical properties, specifications, tolerances and other data on extruded aluminum bronze rectangles for wear and abrasion applications. **71**

Beryllium Copper. Beryllium Corp., 48 pp, illus. Advantages, properties, composition, typical applications, available forms, and information on how to select various beryllium copper alloys. Included is information on fabricating, heat treating, joining and corrosion resistance. **72**

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Die Castings. Dollin Corp., 16 pp, illus. Facilities for die casting large and small parts of zinc and aluminum. **75**

Aluminum Castings. Exalco Mfg. Co., 4 pp, illus. Information on standard and custom-made aluminum permanent mold castings. **76**

Aluminum Sheet. Fairmont Aluminum Co., 4 pp. Dimensional data, uses and physical properties of wrought aluminum sheet. **77**

Nonferrous Metal Powders. Glidden Co., Chemical Divs., Metals Dept., 6 pp. Information on lead and Resistox copper powders. **79**

Indium Alloys. Indium Corp., of America, 93 pp, graphs. Constitution of indium alloy systems. **80**

Beryllium Copper Parts. Instrument Specialties Co., Inc., 20 pp, illus., No. 10. Design information, properties and uses of beryllium copper springs and screw machine products. **81**

Copper Powder. Malone Metal Powders, Inc., 4 pp, illus. Describes Fernlock Copper, made by electrolysis and having a dendritic particle shape and low density. **82**

Phosphor Bronze. Miller Co., Rolling Mill Div., 4 pp, illus. Composition, properties, uses and availability of phosphor bronze coils and flat lengths. **83**

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Die Castings. Doehler-Jarvis, Div. of National Lead Co., 6 pp, illus. Advantages and limitations of zinc, aluminum and magnesium die casting alloys. Case histories on the use of die castings in chain saws and movie cameras. **84**

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Plastics & Rubber • Parts • Forms

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TECHNICAL LITERATURE

shapes. Gives physical properties, dimensions and uses. **97**

ABS Rigid Plastics Pipe. American Hard Rubber Co., Div. of Amerace Corp., 16 pp, illus., No. CE-80. Corrosion resistance, fabrication data, dimensions and uses of ABS (acrylonitrile-butadiene-styrene) rigid plastics pipe, fittings and valves. **98**

Tube and Pipe Insulation. American Marietta Co., Presstite Div., 4 pp, illus., No. PE 5840. General information, physical and chemical properties, advantages, and uses of expanded neoprene insulation for tube and pipe. **99**

Reinforced Plastics Filter. Atlas Powder Co., Chemicals Div., 4 pp, illus. Cost, weight and properties of a reinforced plastics filter plate. **100**

Polypropylene. Catalin Corp. of America, 4 pp. Heat and chemical resistance, electrical properties, finishes, and applications of polypropylene. **101**

Standards for Reinforced Plastics Parts. Ceilcote Co., Inc., 6 pp, illus. Visual standards and materials specifications for reinforced plastics processing equipment and ventilating systems. **102**

Plastics Moldings. Chicago Molded Products Corp., 12 pp, illus. Data on custom compression molding of melamine and urea plastics. **103**

Hardener for Epoxy Resins. Ciba Products Corp. 10 pp, illus., No. 25. Typical properties, applications, pot life and curing cycles of a safety hardener for epoxy resins. **104**

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Standard Plastics Compounds and Dies. Conneaut Rubber & Plastics Co., 4 pp, illus. Lists standard plastics compounds kept in stock, and illustrates in silhouette the many die shapes available for extruding. **106**

Plastics Moldings. Continental-Diamond Fibre Corp., 12 pp, illus. Information on compression, transfer and injection molded plastics parts. Properties of molding materials and typical molded parts. **107**

Thermal Insulation. Dow Chemical Co., Plastics Sales Dept., 12 pp, illus., No. 157-57. Design information, physical and thermal properties, and installation data for a thermal insulation made of polystyrene foam. **108**

Polyethylene. E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., 8 pp, illus., No. A-11687. Applications, properties and characteristics of polyethylene coatings, film and moldings. **109**

Rubber, Vinyl Parts. Ohio Rubber Div., Eagle-Picher Co., 6 pp, illus., No. 715. Information on rubber parts, and molded and extruded vinyl parts. **110**

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Diallyl Phthalate Laminates. Food Machinery & Chemical Corp., Chemicals & Plastics Div., 24 pp, No. 2. Covers recommended materials, equipment and production techniques, selection of core materials, and properties of laminates based on diallyl phthalate resins. **112**

Masterbatch Rubbers. Goodrich-Gulf Chemicals, Inc., 16 pp, illus. Properties and uses for seven types of black masterbatch synthetic rubbers. **113**

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Fabricating Plastics Parts. Sinko Mfg. & Tool Co., 4 pp, illus. Facilities for injection molding, vacuum distillation plating, hot stamping, painting and assembly of plastics parts. **121**

Vulcanized Fiber. Spaulding Fibre Co., Inc., 40 pp, illus. Available grades, physical and mechanical properties, sizes and typical applications of vulcanized fibre sheet, rod and tubes. Also included is information on copper clad laminates, standard plastics laminates, and other materials. **122**

Small Plastics Parts. Standard Plastics Co., Inc., 8 pp, illus. Describes a custom service for molding thermoplastic and thermosetting resins into small plastics parts, such as lenses, bearings and jewelry. **123**

Engineered Rubber. Stoner Rubber Co., Inc., 28 pp, illus. General information on materials, facilities and services available for the production of molded, extruded, calendered and injection molded rubber parts. **124**

Plastics Liners for Truck Trailers. U. S. Rubber Co., Royalite Div., 10 pp, illus. Sizes installation data, maintenance and repair of plastics liners for truck trailers. **125**

Other Nonmetallics • Parts • Forms

Fibers. American Viscose Corp., 50 pp, No. 5005. Properties of synthetic and natural fibers; glossary of textile terms; spinning twist calculator; denier conversion table; packaging data; and products, services, trademarks and other information on fibers. **126**

Printed Circuit Boards. Corning Glass Works, 2 pp, illus., No. CE-3.00. Characteristics, advantages, properties, and other data on glass-ceramic printed circuit boards. **127**

TFE-Coated Glass Fabrics. E. I. du Pont de Nemours & Co., Inc., Fabrics Div., 8 pp. Mechanical, electrical, chemical and thermal properties, uses and formability of TFE fluorocarbon resin-coated glass fabrics and laminates. **128**

Felt Design Book. Felters Co., 24 pp. Information on design properties of felt, descriptions of special treatments, and data on how to select the proper shapes and dimensions for specific applications. Also included are data on felt lubrication seals, gaskets, wicking and filters. **129**

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Graphite. Great Lakes Carbon Corp., Electrode Div., 8 pp, illus. Outstanding characteristics, chemical composition, properties, and typical applications of graphite in atomic energy, metallurgy, metal fabricating, aircraft and missiles, chemical processing, etc. **131**

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Cellulose. Rayonier Inc., 12 pp. Comprehensive article covers production, consumption, prices, supply, typical uses and other information on chemical cellulose. **138**

Sintered Metallic Oxides. U. S. Stoneware Co., Alite Div., 8 pp, illus., No. A-7R. Electrical characteristics, size limitations, dimensional tolerances, chemical and heat resistance, and physical properties for a series of sintered metallic oxides called Alite. **139**

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Ultrasonic Cleaning. Branson Ultrasonic Corp., 24 pp, illus., No. S-200. Applications, advantages and operation of ultrasonic cleaning equipment used for automotive, aircraft, electronic, electrical and optical parts. **142**

Silver Electroplates. Englehard Industries, Inc., American Platinum & Silver Div., 4 pp. Tells how to silver plate ferrous and nonferrous metals **143**

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Metallized Ceramic Coating. Frenchtown Porcelain Co., 4 pp, illus. Data on Molcote, metal-to-ceramic coating, that may be hard soldered up to 2200 F. **145**

Nickel Alloy Coatings. Kanigen Div., General American Transportation Corp., 12 pp, illus., No. 258. Frictional properties, abrasion, corrosion and salt spray resistance, uses, ductility and thermal conductivity of Kanigen chemically deposited nickel alloy coatings. **146**

Epoxy Coatings. Hauger-Beegle Asso. Inc., 22 pp, illus. General description, advantages, uses, available colors and methods of applying a line of epoxy coatings. **147**

Hard Surfacing Electrodes. Metal & Thermit Corp. File cards give data or 88 types and sizes of hard surfacing electrodes and rods. **148**

Fusion Coatings. Michigan Chrome & Chemical Co., 6 pp, illus. Information on small particle size plastics powders for use in fluidized bed coatings. Information also on equipment for fluidized bed coating. **149**

Urethane Coatings. Mobay Chemical Co., 4 pp, illus. Corrosion, oil and solvent resistance, flexibility, abrasion and wear resistance, and light reflectance for urethane coatings. Information on the use of urethane coatings on metal, wood, rubber and plastics. **150**

Fusion Bond Finishes. Polymer Corp., Whirlclad Div., 4 pp, illus. Characteristics, properties and uses of Corvel cellulosic, nylon, polyethylene and chlorinated polyether finishes for metal parts. **151**

Porcelain Enamel. Porcelain Enamel Institute, 1145 19th St., N. W., Washington 6, D. C. File folder covers general information about porcelain enamel, gives characteristics, properties and corrosion resistance of porcelain enamel. Write on company letterhead directly to Porcelain Enamel Institute.

Electrostatic Painting. Ransburg Electro-Coating Corp., 4 pp, illus. Describes an electrostatic hand gun for spray painting hardware, appliances, metal furniture and other products. **152**

Selective Plating. Sifco Metachemical Inc., 4 pp, illus. Process of electroplating selected areas without using immersion tanks. For quick precision plating of electronic components and build-up of parts to exact size without disassembly. **153**

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Plastics Welding Kit. American Agile Corp., 2 pp. Information on a plastics welding kit (that comes complete with tools, supplies and operating instructions) used for field or in-plant maintenance, or for production welding of any thermoplastic fabrication. **154**

Metal Sealant. American Sealants Co., 8 pp, illus., No. 204a. General information, methods of application, information on how to select the proper type, typical uses, and technical data on a liquid sealant for assembling metal parts. **155**

Fluorocarbon Etchant. Chemgineers, Inc., 2 pp, No. 369. Information on a solution used to prepare the surface of fluorocarbon plastics for bonding, including instructions on cleaning, methods of application and safety precautions. **156**

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Adhesives. Firestone Tire and Rubber Co., Xylos Rubber Co., Div., 16 pp, illus. Advantages, characteristics, design hints, and typical applications of a line of industrial adhesives. Included is a glossary of adhesives terminology and a selector chart listing recommended adhesives for specific combinations of materials. **179**

Die Cast, Molded Fasteners. Gries Reproducer Corp., 8 pp, illus., No. 2002. General information, properties, specifications, advantages, uses and other information on a line of diecast zinc alloy and molded nylon fasteners. **160**

Industrial Fasteners. National Machinery Co., 16 pp, illus. Information on facilities, services and equipment available for the production of a variety of industrial fasteners. **162**

Adhesives. Raybestos-Manhattan, Inc., Adhesives Dept., 1 p. Large chart gives general descriptions, characteristics, solvents used, typical applications, and bonding requirements of a line of synthetic adhesives. **163**

Ultrasonic Solderer. Sonobond Corp., 8 pp, illus., No. SP-8. Specifications, advantages, characteristics, typical uses, and other information on a line of ultrasonic fluxless soldering equipment. **177**

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Methods for Joining Metals. Linde Co., Div. of Union Carbide Corp., 36 pp, illus. Discusses various welding techniques for joining ferrous and nonferrous metal parts such as tanks, railroad cars, condensers and bulldozers. **166**

Industrial Adhesives. U. S. Rubber Co., Adhesives & Coatings Dept., 4 pp. Uses, characteristics, colors, solvents, viscosity, and other data on a line of industrial adhesives. **167**

Brazing Alloys. Wall Colmonoy Corp. Brazing Alloys Div., 2 pp, No. 16. Gives nominal composition, solidus and liquidus temperature, brazed joint ductility, and recommended brazing temperature and atmospheres for 11 brazing alloys. **168**

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Universal Testing Machine. Budd Co., Instruments Div., 4 pp, illus., No. BM-2090. Specifications, characteristics, advantages, and other information on a testing machine designed to perform tension, compression and flexure tests. **170**

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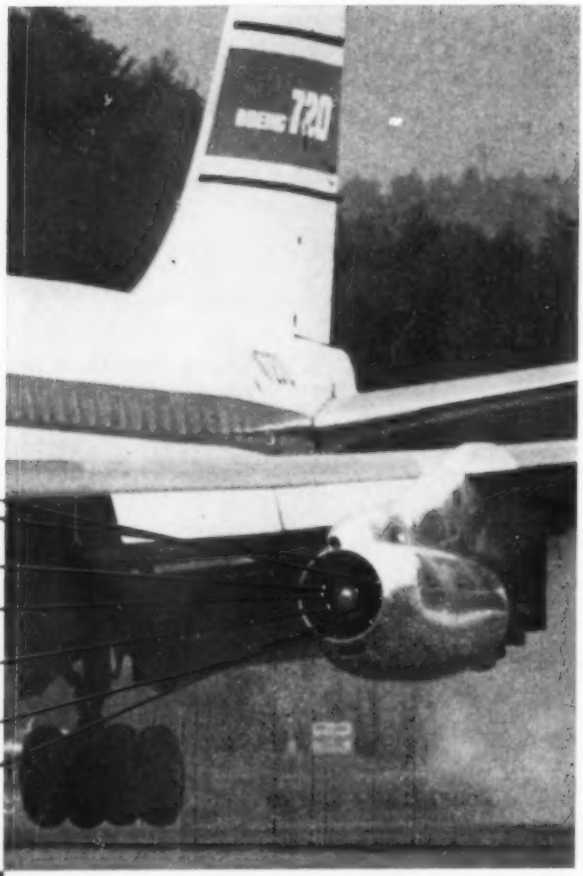

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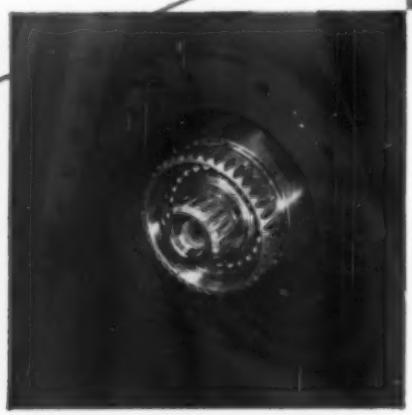

Thrust reverser bearing assemblies, made of Latrobe's Vac-Arc BG 41 Stainless, take compressive stresses of more than 600,000 psi and temperatures in excess of 800°F. as new Boeing 720 jetliner brakes to a stop. Bearings by Torrington Co.; Thrust Reversers by Rohr Aircraft; Jet Engines by Pratt & Whitney Aircraft.

VAC-ARC BG 41 "hot hardness" withstands critical braking action of new Boeing 720

Through the use of thrust reversers and wheel brakes, the new Boeing 720 has been brought to a full stop within 2200 feet after runway touchdown—bringing high speed jet service to restricted runway facilities throughout the world.

The thrust reverser bearing assemblies, made of Latrobe's new Vac-Arc BG 41 Stainless (modified Type 440 C), withstand the critical stresses at elevated temperatures imposed by the braking action of reversing the jet engine thrust.

Here's another example of Latrobe Metalmasters meeting the challenge for super steels in the jet and missile age. Vac-Arc Steels (consumable electrode vacuum melted) continue to set new standards for cleanliness, homogeneity and high strength.

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PREVIEW

1960 Metal Show

42nd National Metal Exposition and Congress, Oct 17-21

The Exhibits

Approximately 25,000 people are expected to visit some 300 separate exhibits at Philadelphia's Trade and Convention Center during the 42nd National Metal Exposition. The theme of this year's show is "A Competitive America through Improved Technology."

According to Allan Ray Putnam, ASM managing director, this year's Show will provide ". . . the greatest concentration of technical exhibits on metals, forms and shapes, and processes in the 42-year history of the ASM Metal Shows."

A new and unique feature of the Show will be the Steel Arena—a special area containing exhibits prepared by 16 of the country's major steel companies. Theme of the Arena is "Build It Better with America's Steel—Basic Material of Construction." Purpose of the Arena is to dramatize, with hundreds of samples of steel products, the latest advances in metalworking technology. In addition, some 200 experts in every phase of steel—engineering, metallurgy, production, and marketing—will staff the arena exhibits to provide a "reservoir of technical information unique in an industrial exposition." These consultants will answer all questions.

Another unique feature of this year's show is the strict control over individual exhibits. According to ASM, extensive personal interviews were conducted to determine the type of exhibits that previous registrants felt would be most helpful. As a result of these interviews, 11 product categories were established as the basis of acceptance for exhibitors. All exhibits at the Show, therefore, will be concerned with one or more of the following: ferrous metals; nonferrous metals; related engineering materials; nuclear materials and equipment; tool materials; industrial heating equipment and supplies; cleaning and finishing equipment and supplies; welding and joining equipment and supplies; testing, inspection and control equipment and supplies; metal production and casting equipment and supplies; and parts, forms and shapes for design and application.

Exposition hours are from 10 a.m. to 6 p.m. on Monday, Thursday and Friday, Oct 17, 20 and 21; and from noon to 10 p.m. on Tuesday and Wednesday, Oct 18 and 19. A complete list of exhibitors and their booth numbers is given on pp 53 and 55. Visitors will be especially welcome at M/DE's booth, 1256.

The Technical Program

This year, as last, the National Metal Congress will be sponsored by the American Society for Metals in cooperation with the Metallurgical Society of the American Institute of Mining, Metallurgical and Petroleum Engineers; Society for Non-Destructive Testing; Industrial Heating Equipment Assn.; Metal Treating Institute; Ultrasonics Mfg. Assn.; Special Libraries Assn.; and Metal Powder Industries Federation.

In addition to the many technical programs offered by these societies, the following special events have been planned: 1) an ASM seminar on "Strengthening Mechanisms in Solids"; 2) an ASM-AEC seminar on "Non-Oxide Nuclear Fuels"; 3) a special "Symposium for Steel Users"; and 4) ASM's Metals Engineering Program Committee Conference (Woodside Memorial Panel).

A condensed program covering technical sessions of ASM, AIME, SNDT and MEPC appears on p 49. Complete sessions of particular interest to engineers and designers engaged in materials selection and use are listed on page 51. Listed at right are the programs of the other cooperating societies:

Tuesday, Oct 18, Industrial Heating Equipment Assn. will present five papers on heat treating of stainless steels: Atmospheres and Furnaces, Brazing, Vacuum Furnaces, Flat Products, and Tube and Wire.

Wednesday, Oct 19, Metal Powder Industries Federation will present four papers: Sintered Brass, Ceramic Molds, Thin Walled Cones, and Iron Powder by the Fluidized Bed Method.

Thursday, Oct 20, Metal Treating Institute will present two papers on heat treating components for space age products: Vacuum Heat Treating, and Heat Treating Specifications.

Thursday, Oct 20, Ultrasonics Mfg. Assn. will present four papers on ultrasonics: Dissimilar Metal Joining by Ultrasonics, Developments in Ultrasonic Equipment, New Applications, and Cleaning Shot Blasted Strip.

Thursday, Oct 20, Special Libraries Assn. will present three papers on joining metals: Fundamentals of Inert-Gas Shielded Consumable Electrode Process, Inert Gas Tungsten Welding in Aircraft and Missiles, and Silver Brazing.

Condensed Program of Technical Sessions[a]

42nd National Metal Congress and Exposition

Society →	AMERICAN SOCIETY FOR METALS Bellevue-Stratford	ASM METALS ENGINEERING CONFERENCE Bellevue-Stratford	AMERICAN INSTITUTE OF MINING, METALLURGICAL AND PETROLEUM ENGINEERS Sheraton	SOCIETY FOR NONDESTRUCTIVE TESTING[b] Benjamin Franklin
Mon, Oct 17				
Morning	• Physical Metallurgy	• Materials for the Aerospace Age—12	• Thermodynamics (abstracts) • Advances in Stainless Steel Metallurgy—11 • Diffusion	• Inspection of Steel
Afternoon	• Physical Metallurgy	• Metal Joining	• Ingot Structure Control • Imperfections (abstracts) • Advances in Stainless Steel Metallurgy—4 • Ingot Structure Control • Metallurgy in the Army—Requirements, Applications and Research	• General Testing—10
Tues, Oct 18				
Morning	• Phase Diagrams • Steel	• Failure Analysis	• Titanium (abstracts) • Process Simulation • Phase Transformation (abstracts) • Effect of Extremely High Pressures—5	• Testing and Quality Control
Afternoon	• Steel • Plastic Deformation	• Failure Analysis	• Titanium vs Steel and Aluminum in Pressure Vessels • Effect of Extremely High Pressures (abstracts) • Hot Extrusion • Physical Chemistry	
Wed, Oct 19				
Morning			• Metallic Moderators and Claddings Materials • Gases in Metals (abstracts) • Austenite Decomposition • Physical and Magnetic Properties (abstracts)	• Electronics • Power and Nuclear Plants
Afternoon	• Steel—7 • High Temperature Materials—1	• Recent Advances in Metallurgical Microscopy	• Refractory Alloy Sheet • Metallic Moderators and Cladding Materials • Structural Materials in Cryogenic Design—9 • Austenite Decomposition • Plastic Deformation (abstracts)	• Applications of Testing in Electronics • Gas Transmission Plants and Piping
Thurs, Oct 20				
Morning	• Nuclear Materials	• Effects of Structure on Properties—8	• Plastic Deformation (abstracts) • Refractory Metals • Powder Metallurgy (abstracts) • Engineering Fundamentals of Rolling Process	• General Testing—6
Afternoon	• Embrittlement—2	• Effects of Structure on Properties—3	• Refractory Metals (abstracts) • Creep, Fatigue and Fracture (abstracts) • Powder Metallurgy (abstracts)	• Quality Assurance in the Field

[a]More details on numbered sessions appear on p 51.

[b]Friday, Oct 21: educational clinics morning and afternoon.

Technical-ities

By Fred E. Graves

No difference between hex and cap screws

It's not the *name* of a standard fastener that determines whether to use it for a particular application, but vice versa. The *application* requirements for strength and tolerances dictate the fastener.

Thus, if you have a joint that calls for certain tolerances in a screw, obviously the one which satisfies those tolerances is the right fastener.

IDENTICAL STANDARDS

In the case of cap screws and hex screws, the standards will show you that these are merely different names for the same product. They're actually made on the same machines, to identical tolerances, and from identical materials.

No reason then to differentiate. For tapped holes, merely specify Hex Screws (SAE Grade 2) or High Strength Hex Screws (SAE Grade 5), and you'll get the *right* fastener with the quality needed.

For bolted joints, these same items are supplied with nuts when specified.

This should suggest a way you can extend standardization in your plant . . . and benefit from our new simplification of nomenclature which calls *any* fastener with head on one end and threads on the other a *screw;* and a screw plus nut a *bolt.*

See how "holding power" can cut fastener costs

SIZE	SAE GRADE	SAE PROOF LOAD	COST RATIO
3/4"	Gr. 5	28,400 lbs.	100%
1"	Gr. 2	16,950 lbs.	188%
1 1/8"	Gr. 2	21,350 lbs.	239%
1 1/4"	Gr. 2	27,100 lbs.	277%

Since the usual job of a threaded fastener is to hold an assembly tightly together, its *clamping force* is what you're really utilizing. This seems obvious. But how best to get the clamping force needed for the joint design? Not so obvious. Looking at size alone can be misleading . . . *and quite costly,* as the chart above demonstrates.

HOLDING POWER MEANS MORE THAN SIZE

SAE "proof load" of four different hex screws of standard steels, along with typical cost ratios, are compared. Almost unbelievable, isn't it? Yet it's a fact that the smallest of the group—the heat treated SAE Grade 5 *RB&W High Strength Hex Screw* exceeds all the others in load capacity. It can be used in place of any of the others in most normal usages.

Since it's smallest and therefore weighs the least, it also costs less... 64% less than the 1¼-inch grade 2 hex screw; 58% less than the 1⅛-inch; 46% less than the 1-inch. And since holes can be made smaller, there are also the savings in production drilling . . . and possibly in materials, too.

DESIGN ADVANTAGE

Remember, too, that smaller fasteners are more easily torqued to higher preload levels . . . which helps keep joints tight, makes them more vibration-proof.

If you would like to explore this approach to fastener economy and better utilization of "holding power," consult with an RB&W specialist. Let him contribute his fastener knowledge to your design and production needs. Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N. Y.

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa., Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

For more information, turn to Reader Service card, circle No. 385

12 Materials Sessions of Special Interest[a]

42nd National Metal Congress and Exposition

1. High Temperature Materials

Constitution of Re-Cb Alloys

Beta Transformation of Titanium Alloyed with Vanadium and Aluminum

Mechanical Properties of Tantalum Alloys

Nickel Alloys for Advanced Temperature Applications

High Strength Martensitic Steels for Elevated Temperatures

Alloying to Improve Ductility of Vanadium Structure and Mechanical Properties of U-Ti Martensitics

Effect of Alloy Additions on Properties of Uranium

2. Embrittlement

Temperature and Microstructure Dependence of Size Effects in Notched Bend Tests of Some Alloy Steels

Embrittlement of High Purity Nickel

Influence of Hot Rolling on Brittle Fracture in Steel Plate

Effect of Induction Tempering on 500 F Embrittlement

Occlusion of Hydrogen by Annealed Hypoeutectoid Iron-Carbon Alloys

Hydrogen Embrittlement in Vanadium-Columbium Alloys

3. Effects of Structure on Properties

Effect of Composition, Structure and Processing on Properties and Application of Iron-Nickel Alloys

Effect of Structure on Properties of Gray and Ductile Irons

APM Alloys

Refinement of Primary Silicon and Eutectic in 21% Silicon-Aluminum Alloy

Effect of Elevated Temperature on Strength and Microstructure of Rene' 41 Microstructure vs. Properties of Titanium Alloys

4. Stainless Steel Metallurgy

Composition vs Stress-Corrosion Cracking

Sub-Zero Rolling of Stainless Steel

Temperature Dependent Fatigue in Austenitic Stainless

Effect of Delta Ferrite on Hot Cracking

5. Effect of Extremely High Pressures

Static Pressure Research in Metallurgy

Phase Transitions of Pure Metals at High Pressures

Shock Waves in High Pressure Studies

6. General Testing

Photostress

Automatic Magnetic Particle Inspection

Experimental Stress Analysis

Density Ratio Method—Radiographs

7. Steel

Corrosion of Stabilized Stainless Welds

Metal Wear by Scoring

Mechanism of Intergranular Oxidation of 18 Cr-8 Ni Stainless (1100-1400 F)

Hardenability Effect of Boron in Steel

Determination of Hardness in Steels from Breadth of X-Ray Diffraction Lines

8. Effects of Structure on Properties

Microstructure vs Notch Toughness of Hardened Steel

Fracture Toughness and Structure of Steels for Pressure Vessels

Heat Treatment Variables vs Fracture Characteristics of Steel

Structural Effects of Strengthening Low Alloy Steels by Deforming Austenite

Influence of Microstructure on Corrosion Resistance

9. Structural Materials in Cryogenic Design

Design Criteria for Cryogenic Tanks

Design Criteria for Airborne Tanks

Cryogenic Structural Materials

Aerospace Materials at Low Temperatures

Temperature vs Fracture Testing of High Strength Sheet

Evaluating Relative Notch-Sensitivity of High-Strength Sheet

10. General Testing

Submarine Steel Weldments

Electron Spin Resonance Spectroscopy

Three Dimensional Presentation of Flaws

Bonded Laminates

11. Stainless Steel Metallurgy

Hardening in 17-7 PH Stainless

Influence of Carbides on Transformation of Semiaustenitic Stainless

Carbides in Austenitic and PH Stainless

Submicroscopic Structures in Tempering 410 Stainless

Creep-Rupture

12. Materials for the Aerospace Age

Properties of Materials for Aerospace Environment

Fabrication Techniques for Aerospace Systems

Selection of Materials for Aerospace Systems

[a]Dates, times and meeting places of these sessions are indicated on p 49.

THESE ARE EXTRAORDINARY FLUXES

The correct selection of flux can offer unexpected help in speeding and simplifying production, minimizing rejects and lowering costs in low temperature silver brazing operations. The advantages to be gained by "selective fluxing" are *sufficiently important to warrant careful, thorough study!*

Silvaloy offers the most advanced flux developments in this specialized field. Here, is *a complete line of fluxes* . . . each providing outstanding performance, enabling you to select the correct flux for every possible low temperature brazing operation. The extra efficiency of Silvaloy "Selective Fluxing" is being proved daily on the brazing production lines of the country's leading manufacturers.

Call the Silvaloy distributor in your area for consultation and detailed information or, send for our booklet "A Complete Guide to Selective Fluxing for Low Temperature Silver Brazing."

Silvaloy fluxes are packaged in 65-lb. and 30-lb. drums, 5-lb. wide mouth jars (5 to a carton), 1-lb. and ½-lb. jars. The wide opening of the 5-lb. package makes it a most practical, time saving dispenser that also enables the operator to make use of every bit of flux in the jar.

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Exhibitors — 1960 Metal Show

Figures indicate booth numbers

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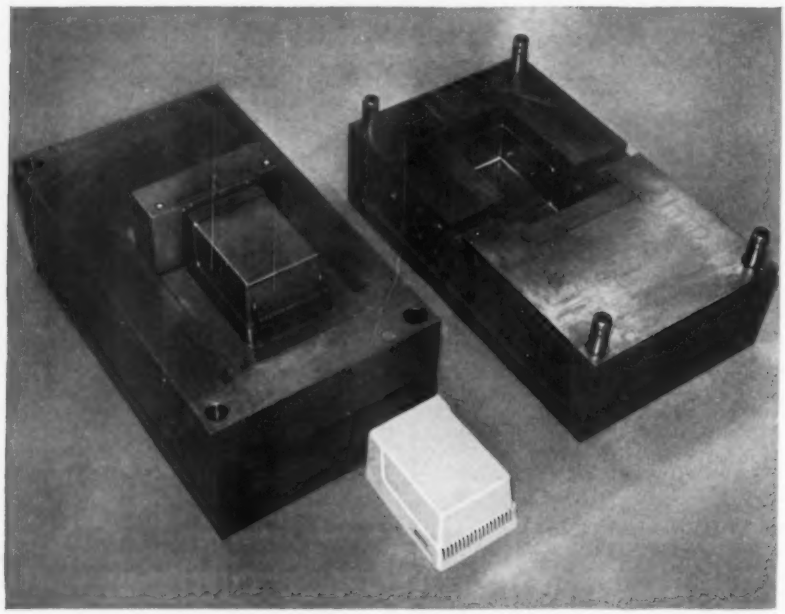
Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.



LUSTRE-DIE does smooth job in molding can-opener housing

Bethlehem Lustre-Die tool steel, which is furnished pre-heat-treated in bars, recently turned out a top-quality molding of high-impact polystyrene at Cepco Plasties Co., St. Louis. The plastic-injection mold, made by Lambert Engineering Co., produced a sturdy, attractive can-opener housing for Swing-A-Way Manufacturing Company.

Here are the reasons why Lustre-Die made such a hit: 1. It saved time, because no heat-treatment was required. 2. It was easier to machine than other pre-hardened grades which were previously used. 3. It polished beautifully, and imparted a high sheen to the finished part.

An electric-furnace steel with a well-balanced basic analysis, Lustre-Die is ideal for working with plastic because it takes a glossy polish. This tool steel also has something extra: a special alloy fortification which further increases its depth of hardenability and enhances its mechanical properties. It is heat-treated by oil-quenching and tempering at the mill, and is furnished ready for machining and polishing. Careful manufacture and quality control insure its freedom from porosity.

You can take our word for it—Lustre-Die is just what you need for a good plastic-molding job. For full details, and prompt delivery, get in touch with your Bethlehem tool steel distributor.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Straighten tools while they are hot

Though seldom recognized or appreciated, straightening is an essential part of the quench and temper hardening operation on long, slender tools. The correction of warpage which occurs either in heating tools to the quenching temperature, or from stresses generated in the quench, must be done during heat-treatment. Only minor straightening can be done on hardened tools at room temperature after the hardening operation is complete.

For example, the major straightening on a long rectangular shear blade must be done during quenching. The heat-treater learns by experience at what point the quench can be interrupted so that straightening can be performed. This point varies with the grade of tool steel, and the size and shape of the shear blade. Straightening usually is performed by bending the tool slightly on a press (so-called gag straightening).

Small amounts of additional straightening can be accomplished when the tool is at the tempering temperature. Or, if necessary, this can be done by reheating to a point just below the final tempering temperature.

Minor mechanical adjustments in the final assembly of tools and components are often made by peening the concave surfaces with a hand hammer. This should be done cautiously to avoid spalling or cracking. However, it is preferable to straightening by cold-bending.

New Booklet on Oil- and Air-Hardening Grades

We have a new illustrated booklet on oil- and air-hardening tool steels. It presents essential data about the BTR, Air-4, Lehigh H, and A-H5 grades. For your copy, write to Publications Dept., Bethlehem Steel Co., Bethlehem, Pa. Ask for Booklet No. 532.

Exhibitors — continued

DOW

NEWS ABOUT PRODUCT DESIGN AND MATERIALS

Rare indeed is the design that cannot benefit from the application of today's plastics materials. From the ultra-high performance standards required by America's weapons program, to the equally high standards demanded by America's army of consumers, plastics are meeting the toughest tests head-on . . . and passing them with flying colors. For example . . .

HOW MODERN PLASTICS HELP MAKE MISSILES GO... BUSINESS FLOW

One of the most challenging problems today's design engineer has is the development of missile components that will stand up under severe firing conditions. In many cases, designers are meeting this challenge with the help of modern plastics materials. Here, for example, is how a Dow thermosetting resin helps keep the Minuteman Missile at readiness for instant firing.

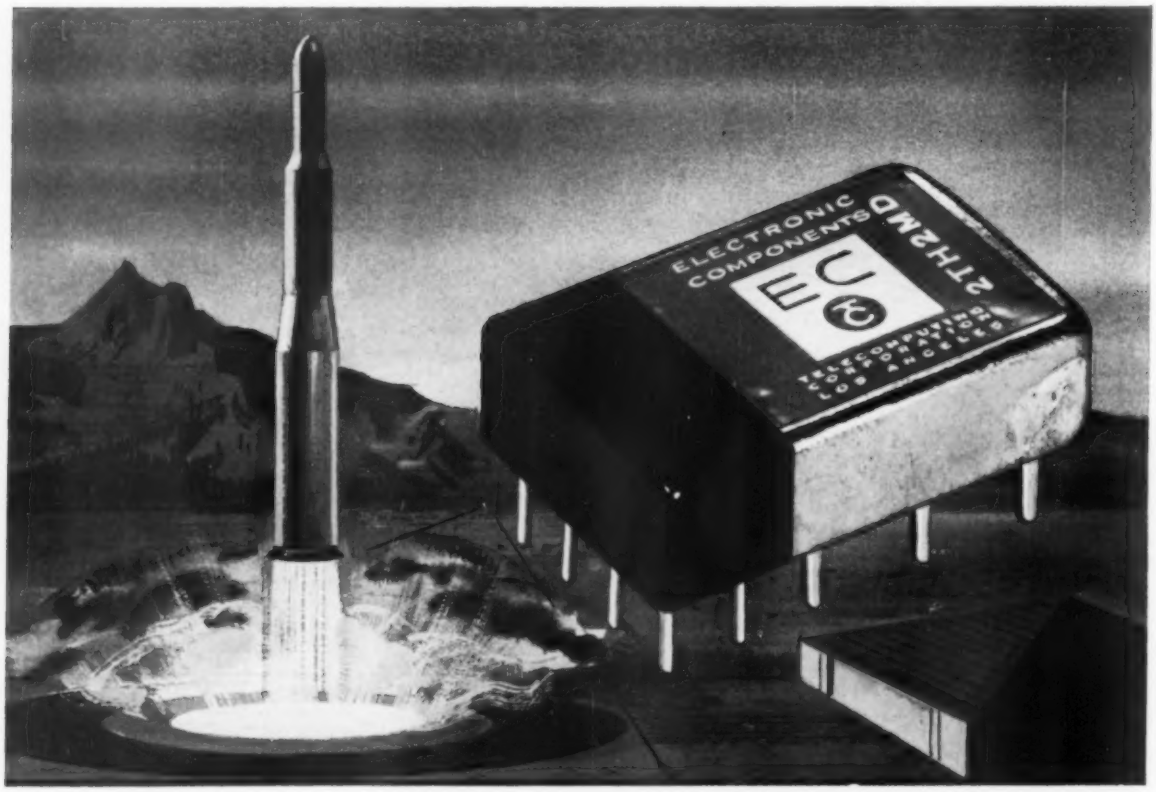
Producing relays for the ground checkout system of one of America's new missiles, a major electronic component manufacturer had to meet rigid design and performance requirements.

Their relay, a micro-miniature plug-in unit, was designed to be potted in an epoxy compound to give the connector mechanical stability and to assure electrical insulation.

In the process of selecting a potting compound, the designer made a series of heat and chemical torture tests. One test, to determine the effects of a prolonged, intense heat, was conducted with two potting formulations—one a high quality conventional epoxy resin, the other Dow Epoxy Novolac (D.E.N.* 438). The relays were placed in a 180°C. oven. After five hours, the conventional epoxy resin potting cracked. But after 100 hours of continuous 180°C. heat, the potted terminal made from Dow Epoxy Novolac was unharmed!

To compare the ability of each potting to withstand chemical action, they were soaked in a high-powered degreasing solvent. The ordinary epoxy resin formulation was completely dissolved after only 48 hours in the solvent. But the

*Trademark



potting made from D.E.N. 438 showed no significant change, even after two weeks' immersion in the same solvent!

Other applications, too. Whether it's for molding, encapsulating or laminating electronic components, or to give coatings and adhesives special qualities, designers are sure to benefit from the hardness, toughness, dimensional stability and chemical resistance of this new Dow polymer.

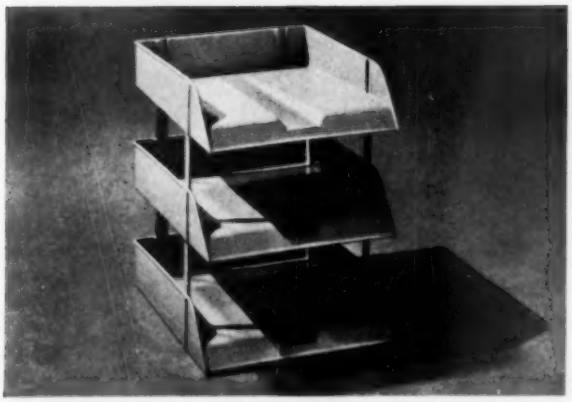
Other Dow plastics materials are performing equally important jobs helping to maintain the flow of modern business. Dow thermoplastics, for example, are contributing durability, attractive appearance, impact strength, moldability, chemical resistance, and other qualities to adding machines, mechanical pencils and pens, letter baskets, wastebaskets.

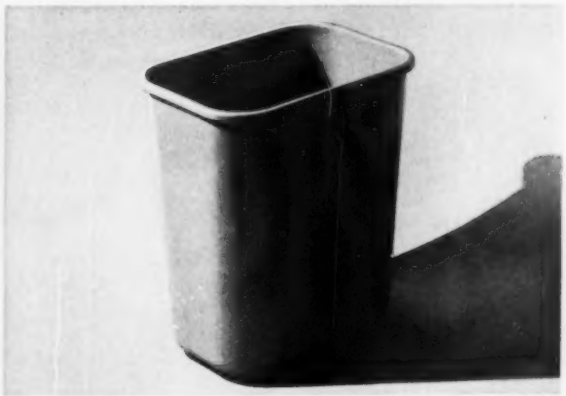
High impact resistance is one of the main qualifications for the cover and front panel of this adding machine. The designer chose a formulation of Dow polystyrene – Styron® 440 – for its impact strength and low gloss. Furthermore, the parts made of Styron have built-in color, eliminating a four-step painting operation. The use of Styron 440 has provided a substantial savings in production costs, and combined with the designer's skill, has resulted in an attractive, compact, durable product.

The exceptional moldability of Tyril®, a Dow copolymer of styrene and acrylonitrile, not only gives these pen and pencil barrels an attractive, smooth, glossy appearance, but it enables the manufacturer to achieve a tight plastic-to-metal bond. Molded with finely detailed screw threads, the barrels hold the metal parts with exceptional strength, and can be screwed on and off, again and again without losing their firm grip on the metal.

Another formulation of Styron, Styron 475, gives an exceptionally high degree of impact resistance to a three-tier office letter basket. Styron 475 has three to five times greater impact strength and nine times greater elongation than general-purpose polystyrene formulations. Each tier is held up by thin posts of Styron 475 that fit into slots in the sides of the baskets. The high impact characteristics of this formulation prevent splitting or cracking at these points of stress, and combine this toughness with a pleasing, graceful appearance.

Molded in color, the flexible wastebasket of Dow polyethylene is a natural application of this versatile Dow plastic material. Inert polyethylene makes it sanitary and easy-to-clean, rustproof, noiseless. Available in a wide range of formulations for both molding and extruding, Dow polyethylene provides utility in a wide variety of applications.





ARE YOU ON RECORD? Have you a design problem that might be solved by one of the versatile Dow thermoplastic or thermosetting materials? If so, drop us a line. We'll be glad to help you with specialized technical service—from choosing the best formulation to assisting in color styling. Write THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Merchandising Dept. 1724CD10.

See "The Dow Hour of Great Mysteries" on NBC-TV.

THE DOW CHEMICAL COMPANY

Midland, Michigan

DOW

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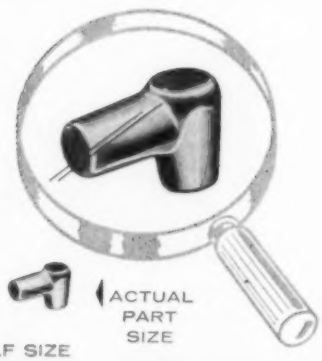
MUELLER BRASS CO. PRODUCES

SPECIFICATIONS . . . *REGARDLESS OF*

To obtain the desired physical and design requirements in a part at the lowest cost, there is usually one specific process by which that part can be most successfully and economically manufactured. Because the Mueller Brass Co. offers a variety of production methods, you get sound engineering, accurate production method analysis, our assurance of getting the best product at the lowest cost . . . regardless of metal specified or the size of your particular part.

BRASS, BRONZE, ALUMINUM FORGINGS

The two parts shown here dramatically illustrate the ability of the Mueller Brass Co. to produce precision forgings regardless of size or configuration. Both the tiny dental drill nozzle and the big heat exchanger shell hub, which is the largest of its kind ever produced, were forged to exacting specifications. The weight of the nozzle is only a few ounces while the shell hub weighs 40 lbs., and has a forged pocket 7 1⁵⁄₁₆″ in diameter and 4³⁄₁₆″ deep. By way of size comparison, the pocket is big enough to hold over 14,000 of these tiny drill nozzles. By forging the pocket, considerable machining time and money was saved. The sound, dense structure of the shell hub makes it ideal for the high pressure application for which it was designed. The forging not only does the job better, but was produced for 25% less than the casting it replaced. Experience makes it possible for the Mueller Brass Co. to produce high quality precision forgings regardless of specifications . . . why not put this experience to work for you?



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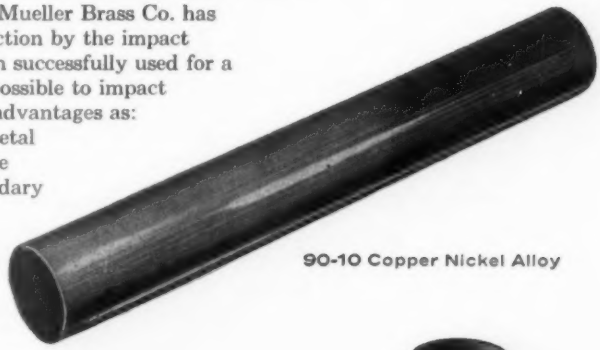
COLD PREST® IMPACT EXTRUSIONS

Today, because of vast experience in alloys, the Mueller Brass Co. has greatly expanded the possibilities of parts production by the impact extrusion method. Aluminum, of course, has been successfully used for a multitude of tubular shapes. But now it is also possible to impact parts of copper alloys incorporating such major advantages as: closer tolerances, better finish and appreciable metal savings. Because of dimensional accuracy possible with the impact extrusion, the necessity of secondary machining operations is often eliminated.

The parts shown here are representative of the group now being economically produced as impact extrusions by the Mueller Brass Co. who offer complete engineering and design service in the development of new parts from copper base alloys.



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CHEMICAL DIVISION

gold plating for electrical and electronic components

Atomic Number	79
Atomic Wgt.	197.20
Crystal Structure	Face center cubic 4.07A°
Density	20°C = 19.3 G/CM³
Melting Point	1063°C
Specific Resistance	13.2 OHMS/MILL/FOOT
Thermal Conductivity	0.71 c g s UNITS (20°C)
Coef. Linear Expansion	14.2 Micro Inches /°C (20°C)
Hardness	Rockwell 15 T Scale = 24
Tensile Strength	P.S.1 x 1000 = 18
Magnetic Susceptibility	.15 x 10^{-6} C.G.S. Units (18°C)

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ATOMEX is a 24K gold immersion solution that permits the deposition of a thin, dense, uniform layer of 24K gold on printed circuits and metallized plastics by means of a simple bath. Atomex deposits gold by Ionic displacement—it is the first practical gold immersion solution containing no free cyanide. The Atomex deposit is more permanent and less expensive than electroplating of comparable thickness. Costly analytical control is unnecessary. Write for literature.

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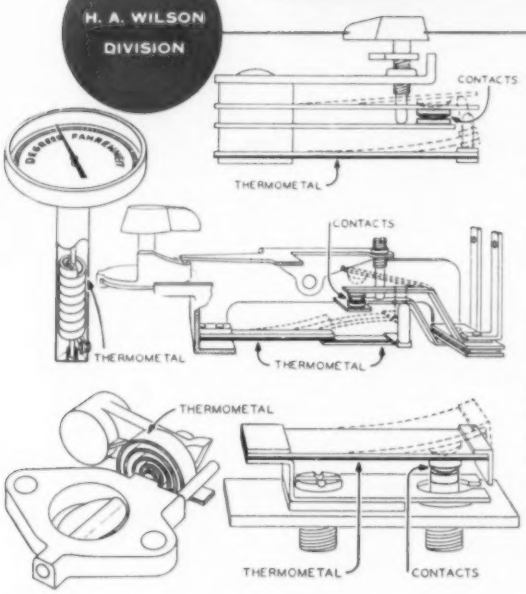

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STEEL

. . . steel that cuts your cost of production

Republic Steel—largest producer of the nation's widest range of bar products—has a new, 11″ bar mill in Chicago that specializes in steel for cold extrusion and cold heading. Features that save you money:

1 **UNIFORM FLOW CHARACTERISTICS**—carbon and alloy steels produced on this mill have denser, more uniform structures because they undergo more hot work. Bigger than usual billets, 3″ and 4″ square, become finished products of standard size.

2 **PRECISE DIMENSIONAL ACCURACY**—16 alternating vertical and horizontal stands with roll neck bearings are utilized to exert uniform pressure on all sides of the bar. This process, along with vertical looping above the mill, eliminates deformations.

3 **ANNEALED, NORMALIZED, SPHEROIDIZED**—new continuous annealing furnaces, capable of all types of furnace treatments, are designed for rigid control of speeds, temperatures, and atmospheres. Other facilities are available to pickle, oil, lime, phosphate, and borax coat bar products.

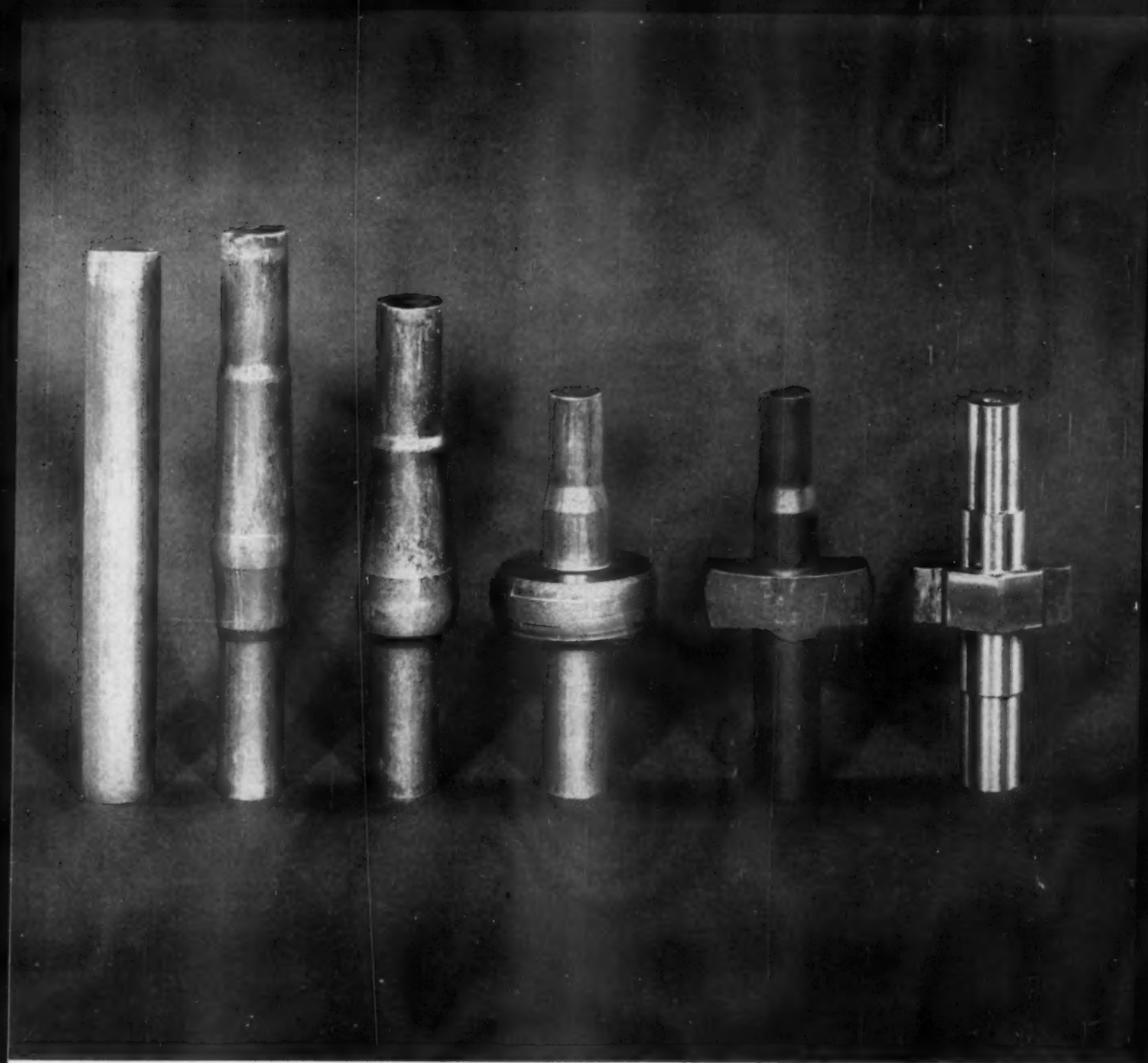
4 **1600-POUND, DOUBLE-BANDED COILS**—four high-speed coilers handle the complete range of coils produced (⅛″ to 59/64″—700 to 900 pounds, ⅝″ to 1½″—1400 to 1600 pounds). Bigger coils cut downtime and scrap loss. Double banding simplifies your handling.

5 **CAPACITY TO MEET YOUR REQUIREMENTS**—this 11″ bar mill produces bar products at rates of up to 3000 feet per minute. Annealing furnaces are the continuous type, capable of meeting the growing demand for furnace-processed steel.

COLD FINISHED, TOO!

Depending upon the nature of your product and the method by which it is made, you may find it more advantageous to use cold extrusion quality steel in *cold finished form,* as did the manufacturer of this gear.

We would welcome an opportunity to serve you on your requirements for both hot rolled and cold finished, cold extrusion quality steel. Our metallurgists will help you select the most economical carbon, alloy, or stainless steel capable of meeting your requirements. For complete data, call your nearest Republic sales office or mail the coupon.



CUTTING THE COST OF A SEGMENT GEAR: ideal blanks are produced by cold heading, cold extrusion, and upsetting. Stock with upset in the center is hot trimmed on a press, after which it is machined into the finished part. Only a minimum of stock need be removed during final machining. Photo courtesy of National Machinery Company, Tiffin, Ohio.

For more information, circle No. 432

REPUBLIC STEEL

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World's Widest Range

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Send more information on cold extrusion and cold heading quality steel.

☐ Hot Rolled ☐ Cold Finished

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____


DONALD L. MILLER

Joe Foster, President,
offers customers Foster Grant's
41 years of molding experience.

"Let me tell you about the world's largest plastics laboratory," says Joe Foster.

That's what customers call our molding room — a **plastics 'laboratory.'**

I'd have to agree with them, too, because I know that we're the only company serving the plastics industry both as a manufacturer of polystyrene, impact polystyrene and Nylon 6 resins, **backed by 41 years of molding know-how.**

This means that as the world's largest manufacturer of sunglasses we use our own powder to mold with. And, believe me, since we introduced injection molding to America in 1931, we've met just about every molding problem in the book.

Our unique combination of raw material and end-product know-how makes it possible for us to help you with machine and mold design, tools and dies, color matching, marketing, styling, packaging and displays.

When you use Foster Grant resins, you draw on unrivaled plastics experience... experience that can help make **your** molding operation more efficient and more profitable.

Why not call or write us today. Foster Grant Co., Inc., Leominster, Mass., KEystone 4-6511.

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Your Partner in Plastics Progress

Plants in Leominster, Mass., Manchester, N. H., Baton Rouge, La.
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For more information, turn to Reader Service card, circle No. 369

Drawing molten glass into 300,000,000 miles of fiber

In this glass fiber drawing process at Gustin-Bacon Manufacturing Company, only a platinum alloy can provide the properties so necessary for the critical furnace. The platinum alloy bushing delivers 16 months service, forms about 300,000,000 miles of fiber.

Where any metal but Platinum would cost too much...

This furnace, or "bushing", is so hot it glows like a fluorescent light. It is designed to act as a resistance heating element to bring the glass to a fluid state, to maintain its critical viscosity.

There are hundreds of tiny holes in the glowing metal, through which molten glass flows to be formed into glass fibers — fibers as fine as .00004" in diameter. *Every minute 10,000 feet of each fiber is formed.*

This metal has to endure severely oxidizing conditions. Crippling temperatures. The eroding effect of streaming molten glass. What metal could provide long enough life . . . be economical enough?

Engineers at Gustin-Bacon — manufacturers of glass fibers — found that a rhodium-platinum alloy was the only metal that could handle this flow of molten glass month after month.

The reasons? This platinum alloy has a melting point well above 3000°F. At fiber drawing temperatures (2400°F) it retains its strength and toughness, provides a hard, wear-resisting surface. Uniform fibers are produced because this alloy doesn't erode or corrode. Doesn't degrade quality.

And after 16 months of continuous service the precious metal is reclaimed and returned to service with only about 1 to 1½% of the platinum alloy lost.

Metal that masters molten glass may master a problem for you

Where conditions involve high temperature, or where a combination of severe erosion and corrosion must be met — as in the production of glass fiber; or where hard, highly conductive surfaces are required — as in the production of printed electrical circuits; or where peak catalytic efficiency is required—as in the refining of high octane gasoline . . . the platinum metals often prove to be the most economical materials for critical equipment.

Perhaps your own progress has been blocked by the limitations of materials to withstand such severe conditions. If so, platinum, palladium, rhodium, ruthenium and iridium — all possessing unique combinations of properties—are well worth your attention and consideration.

Specialists are prepared to work with you in evaluating these metals for new commercial and scientific uses. As a first step, write us for additional data on the outstanding characteristics and successful applications of the six platinum metals and their alloys — indicating your field of interest or how we might be of assistance.

CAN THESE PROPERTIES OF THE PLATINUM METALS HELP YOU?

High Temperature Stability
Superior Wear Resistance
Exceptional Chemical Inertness
Peak Catalytic Activity
Low Vapor Pressure

The six platinum metals are:

PLATINUM • PALLADIUM • RHODIUM • RUTHENIUM • IRIDIUM • OSMIUM

INCO PLATINUM METALS DIVISION

For more information, circle No. 390

The International Nickel Company, Inc., 67 Wall Street, New York 5, N.Y.


bend, stamp, cu
and form away!
this handsome pre-finish
stays put

VINYL-ON-METAL is cooperative. Stamp it out. Punch it out. Even weld it! Form it the same ways you form unfinished sheets. The unique colors, textures and patterns of Vinyl-on-Metal sheeting or coils remain unaffected. The tough resilient surface stays—won't chip or peel in use. It protects against tearing or wrinkling—minimizes surface damage during fabrication and assembly. Vinyl-on-Metal is already widely and successfully used for furniture appliances, transportation interiors, building construction, and in many other fields. For a highly informative booklet, "Vinyl-on-Metal," write to Monsanto Chemical Company, Plastics Division, Room 753, Springfield 2, Mass.

Monsanto developed and today supplies Opalon® and Ultron® vinyls for superior finishes on steel, aluminum, and other metals, and on wood, paper and glass.

MONSANTO DEVELOPER IN **PLASTICS**

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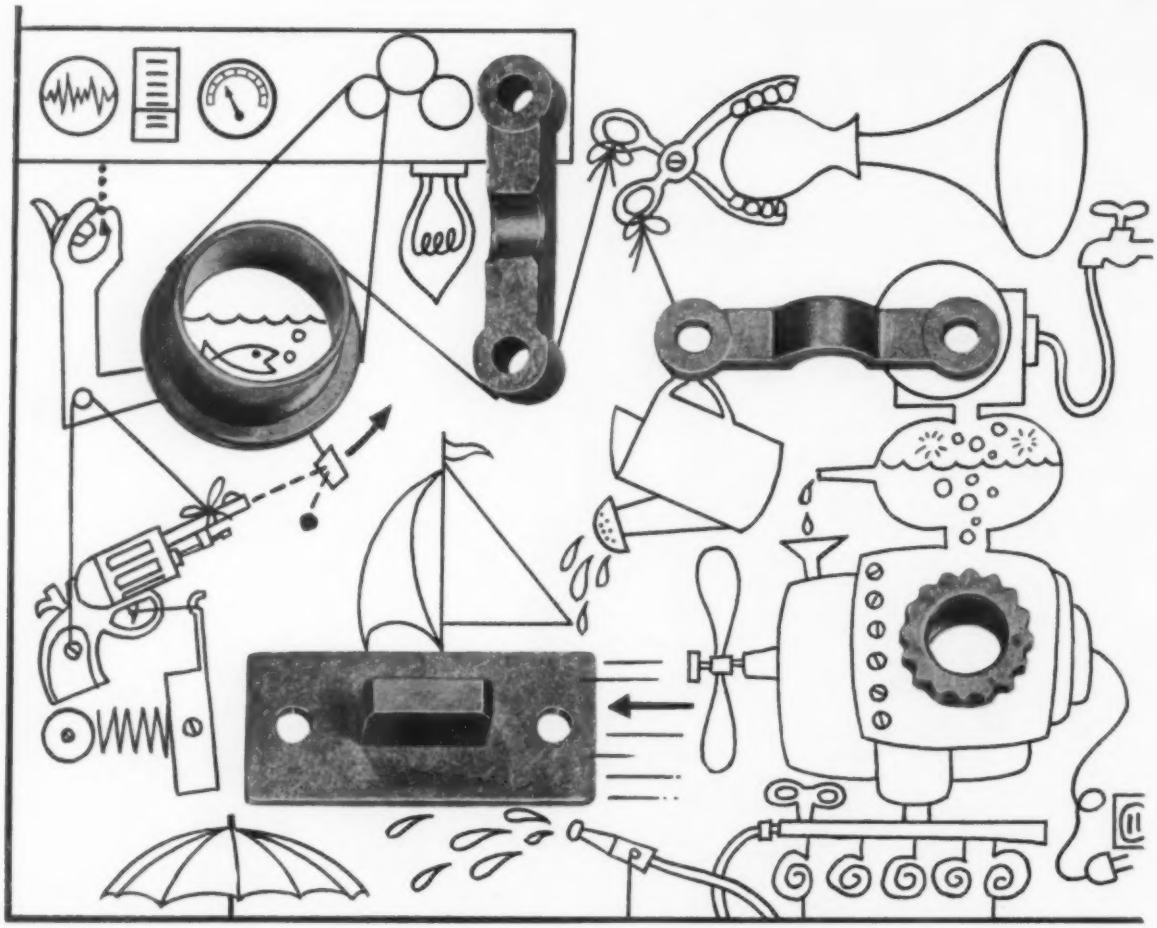

This thing wouldn't run when we plugged it in,

BUT, WE'D LIKE TO SEND YOU THE PIECES*

. . . to introduce you to parts made from superior Glidden Resistox Metal Powders.

You may find that metal powder parts similar to these, or perhaps in entirely different form, can mean substantial savings in manufacture of your products.

Glidden Resistox Metal Powders are prepared by a special process which removes *all* soluble salts, resulting in pure, stable powders for highest finish, appearance and performance characteristics.

Glidden is the world's largest blender and can produce up to 30,000 pounds of powder in a single batch —an important factor in complete uniformity of mass-produced parts.

As a leading supplier of metal powders, Glidden works closely with parts producers. This places the combined training and experience of several staffs of metallurgists and technicians at your disposal.

**Write on your letterhead for sample parts package and further information on powdered metal products.*

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RESISTOX METAL POWDERS

The Glidden Company
Chemical Divisions, Metals Department
Hammond, Indiana

COPPER POWDER • LEAD POWDER • TIN POWDER • BRASS POWDER • ALLOY POWDER • FILTER POWDER
CUPRIC OXIDE • CUPROUS OXIDE • CUPROUS SULFIDE • CUBOND COPPER BRAZING PASTE • COPPER PIGMENT

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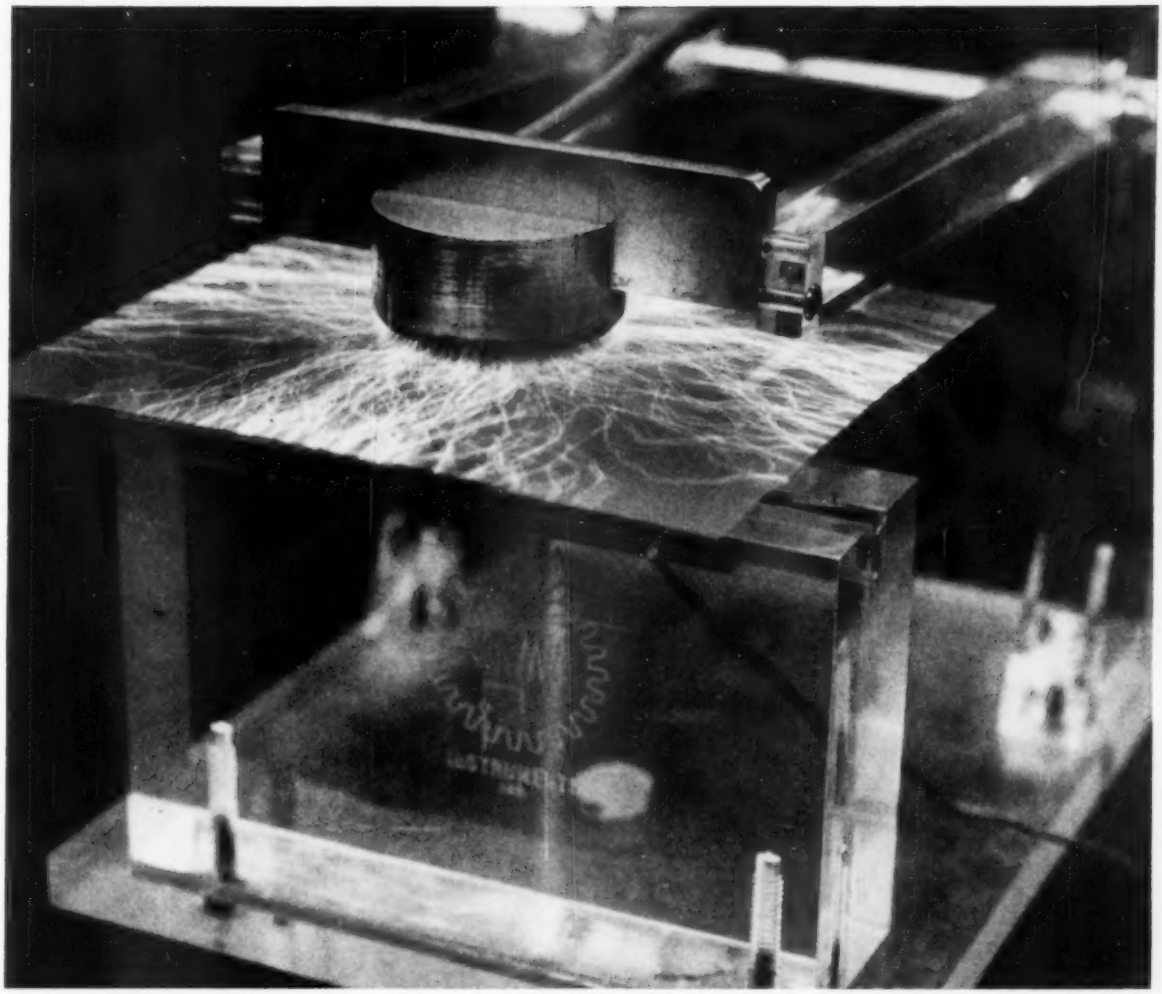
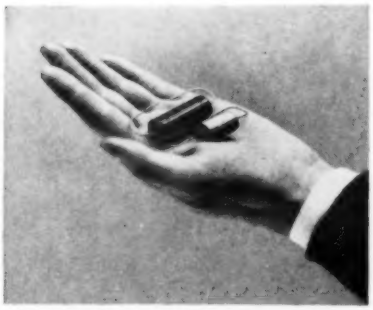


This is an actual photograph of "Mylar" undergoing dielectric strength test (per ASTM-D-149).

MYLAR® has a dielectric strength of 4,000 volts per mil

Can the unique combination of properties found in "Mylar" help you solve your design problems?



High dielectric strength helps cut capacitor size. Tough, thin "Mylar" with a dielectric strength of 4,000 volts per mil for 1 mil film (per ASTM-D-149) permits capacitor manufacturers to reduce size of finished unit . . . improve performance and reliability.

"Mylar"* polyester film is a tough, flexible engineering material. In addition to its outstanding dielectric strength, "Mylar" has an average tensile strength of 20,000 psi, withstands temperature extremes (-60° to 150° C.) . . . resists most chemicals and moisture.

On an area basis, tough, thin "Mylar" often *costs less* than heavier, conventional materials. "Mylar" can be laminated, embossed and metalized, punched or coated. The film won't embrittle with age. "Mylar" is available in roll or sheet form in a wide range of gauges.

Find out how the *combination of properties* in "Mylar" can help you solve knotty design problems, improve product performance or cut costs. Write for our booklet containing detailed information on properties and applications. E. I. du Pont de Nemours & Co. (Inc.), Film Dept., Room M-10, Wilmington 98, Del.

*"Mylar" is Du Pont's registered trademark for its brand of polyester film.

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BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

DU PONT MYLAR® POLYESTER FILM

For more information, turn to Reader Service card, circle No. 355

Illustration of Malleable casting being turned at 1,400 surface feet per minute with a 0.100" depth of cut using an oxide tool.

Cut Machining Time and Costs... Use Malleable

It's the **finished** cost of machined components that's important to you. Remember then . . . Malleable iron is the most readily machinable of all ferrous metals of similar properties. With Malleable castings you'll reduce machining time as much as 50% . . . increase tool life up to 250% . . . get unexcelled surface finishes.

Find out how much you can cut **your** finished parts costs. Contact any nearby Malleable castings producer who displays this symbol—

MEMBER

MALLEABLE

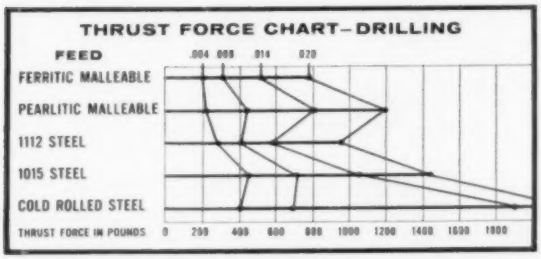
CASTINGS COUNCIL

For detailed information on "Machinability of Malleable Castings", contact any of the progressive companies listed on the opposite page, or Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

You'll Get Faster Machining...Better Finished Surfaces... Longer Tool Life with Malleable Castings

Whatever your machining goals—reduced cycle times, lower tool costs or better surface finishes, you will profit from remembering this fact: Malleable is the most machinable of all ferrous metals of comparable properties.

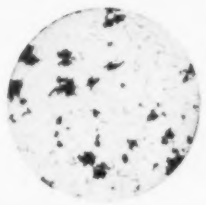
For example, compare the force required to drill Malleable with that required to drill other commonly used metals as we have done here—



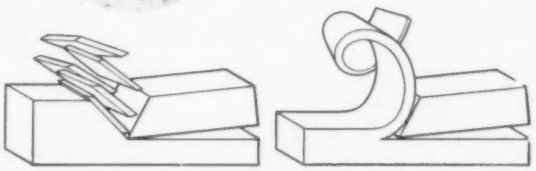
For this test we used ½ inch high speed steel twist drills with a suitable lubricant and a spindle speed of 715 RPM. AISI 1112 steel (Bessemer screw stock) was included because it is often used as a standard for machinability comparisons. Since machining may cost 2 to 4 times as much as the rough parts, the superior machinability of Malleable iron, as demonstrated here, can result in very large savings.

Chips Reveal the Secret of Malleable's Machinability

In addition to providing strength and ductility, Malleable's internal structure of microscopic carbon nodules allows Malleable to break easily into small chips as it is machined. This kind of Type I chip is highly desirable. Speeds and feeds can be increased . . . power consumption drops . . . cutting tools last longer. Malleable's uniform structure permits safe machining at maximum speeds.



Spherical carbon nodules (black) help break up chips. Photomicrograph 50X, etched.



Schematic drawing illustrates how Malleable (left) breaks into short, discontinuous Type I chips, rather than long, continuous Type II and III chips (right).

Future Promises New Triumphs for Malleable

With over two years' experience in advanced machining research, forward-looking Malleable castings producers already know how Malleable will perform when oxide cutting tools come into wide use. In experiments like the one illustrated on the opposite page it has been demonstrated that Malleable can be successfully machined at speeds as high as 1400 surface feet per minute and a 0.100" depth of cut! Surface finish, tool life and metallurgical structure are excellent . . . All this in a metal of rugged engineering properties.

Prove for yourself how much Malleable's machinability will do for your products . . . and your profits. Get in touch with one of the Malleable castings producers listed below. Call today.

Send for Free Machining Information—A special folder, *Data Unit 106, Machining Malleable Iron Castings*, is available from the Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio, or from any member company.

For Quality and Economy...Use MALLEABLE

For Service In Your Area Contact...

CONNECTICUT
Connecticut Mall. Castings Co., New Haven 6
Eastern Malleable Iron Co., Naugatuck
New Haven Malleable Iron Co., New Haven 4

DELAWARE
Eastern Malleable Iron Co., Wilmington 99

ILLINOIS
Central Fdry. Div., Gen. Motors, Danville
Chicago Malleable Castings Co., Chicago 43
Moline Malleable Iron Co., St. Charles
National Mall. and Steel Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
Wagner Castings Company, Decatur

INDIANA
Albion Malleable Iron Company, Muncie Division, Muncie
Link-Belt Company, Indianapolis 6
National Mall. & Steel Castings Co., Indianapolis 22

IOWA
Iowa Malleable Iron Co., Fairfield

MASSACHUSETTS
Belcher Malleable Iron Co., Easton

MICHIGAN
Albion Malleable Iron Co., Albion
Auto Specialties Mfg. Co., Saint Joseph
Cadillac Malleable Iron Co., Cadillac
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MINNESOTA
Northern Malleable Iron Co., St. Paul 6

MISSISSIPPI
Mississippi Malleable Iron Co., Meridian

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Laconia Malleable Iron Co., Laconia

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Frazer & Jones Company Division, Eastern Malleable Iron Co., Solvay
Oriskany Malleable Iron Co., Inc., Oriskany
Westmoreland Mall. Iron Co., Westmoreland

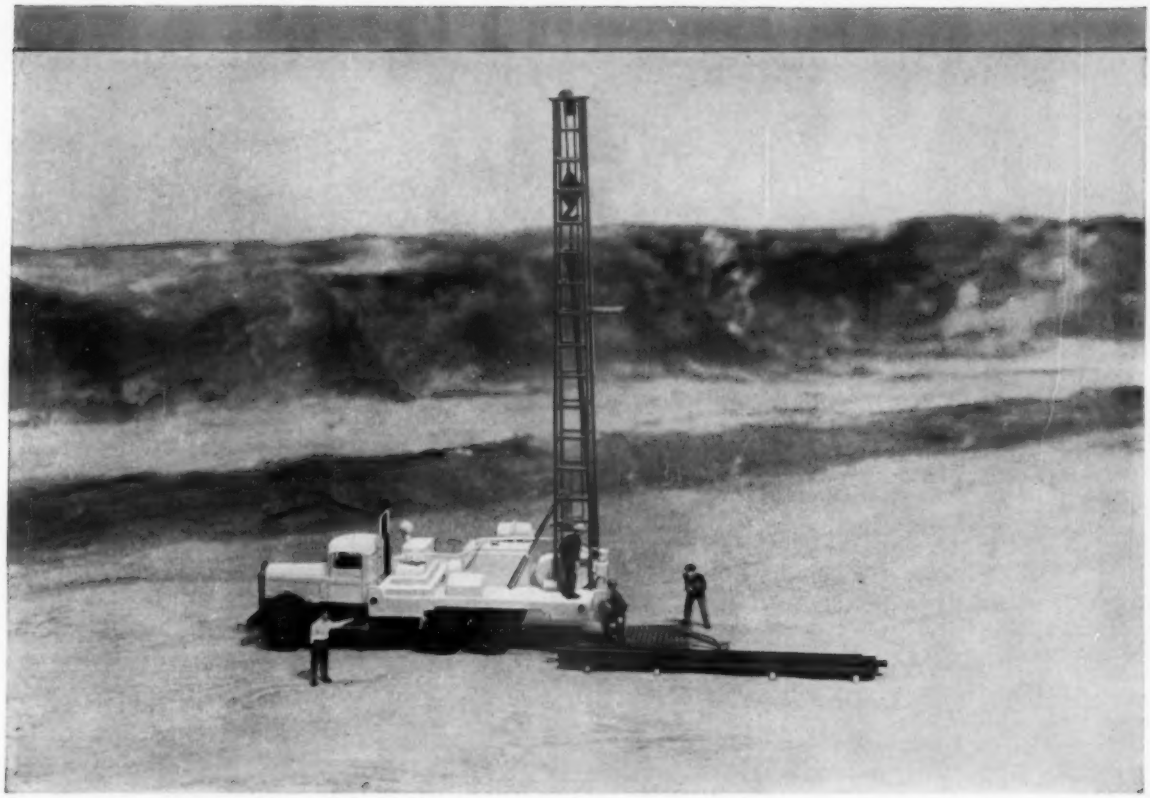
OHIO
American Malleable Castings Co., Marion
Central Fdry. Div., Gen. Motors, Defiance
Dayton Mall. Iron Co., Ironton Div., Ironton
Dayton Mall. Iron Co., Ohio Mall. Div., Columbus 16
Maumee Malleable Castings Co., Toledo 5
National Mall. and Steel Castings Co., Cleveland 6

PENNSYLVANIA
Buck Iron Company, Inc., Philadelphia 22
Erie Malleable Iron Co., Erie
Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries Company, Easton
Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

TEXAS
Texas Foundries, Inc., Lufkin

WEST VIRGINIA
West Virginia Mall. Iron Co., Point Pleasant

WISCONSIN
Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company, Inc., West Allis 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works, Milwaukee 46



Down-to-earth reasons for using Custom Quality OHIO Tubing

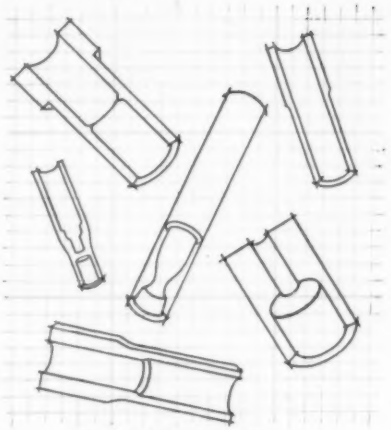
As in rotary drilling, which uses steel tubing internally upset by Ohio Seamless, greater strength and lighter weight may be important in your product.

So before selecting a tubing source consider these important facts. OHIO Tubing is always the exact tubing you need for your product because OHIO Tubing is CUSTOM MADE for your product. Your order is manufactured to your own specifications to produce steel tubing especially for your application — the precise grade, analysis, size, shape, special anneal and tolerances best suited to your needs.

Ohio Seamless Tube produces both seamless and electric welded steel tubing — is prepared to form many finished or semi-finished tubular parts to your designs.

To get the most from your next steel tubing order, use Custom Made OHIO Tubing. Contact your nearest Ohio Seamless representative, or send part drawings to the plant at Shelby, Ohio — Birthplace of the Seamless Steel Tube Industry in America. A-3061A

Model illustrated built to 3.5 mm scale.



Typical Ohio Seamless tubular upset forgings

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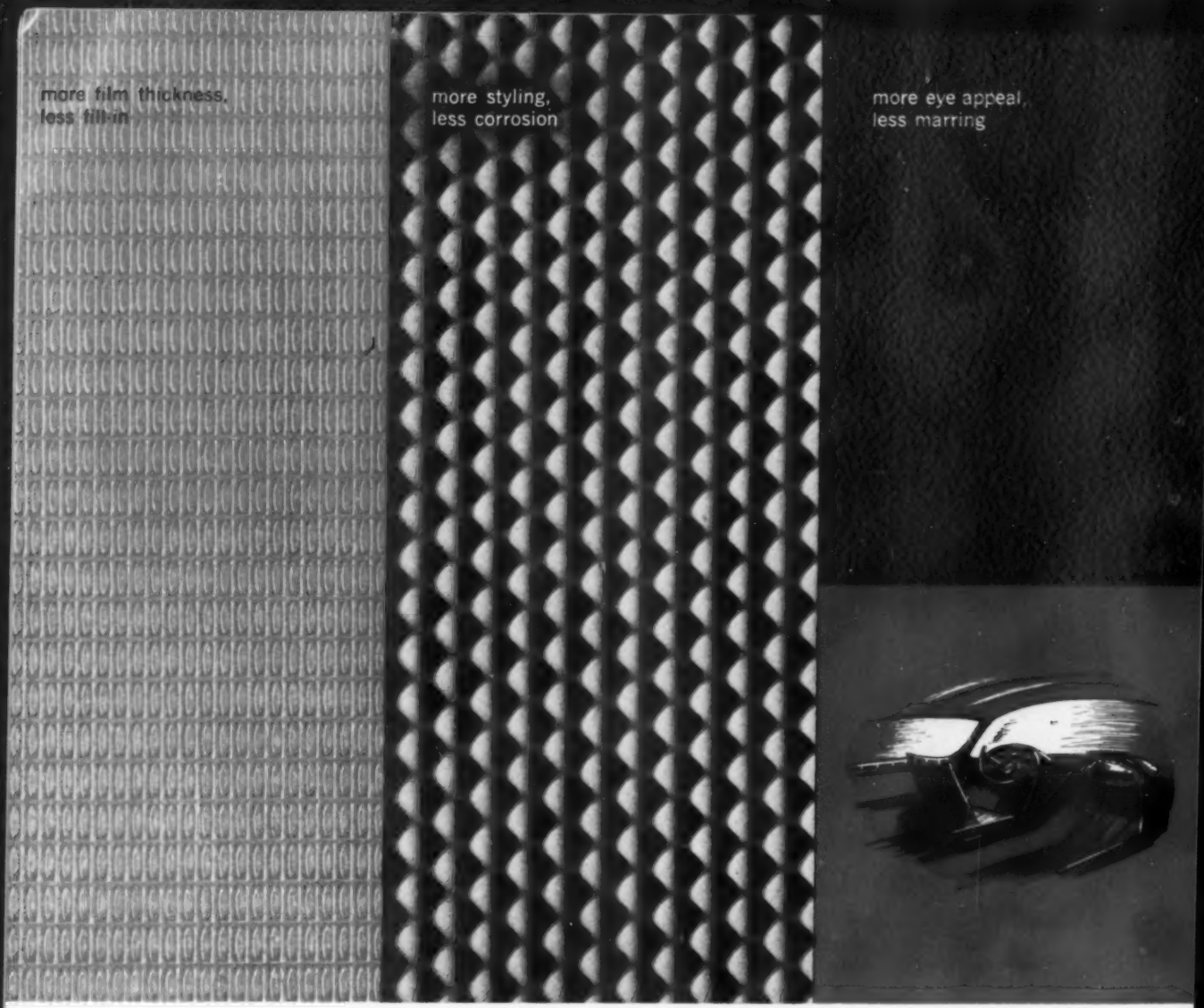

Made for each other... metal plus M&T Spray-on Vinyl Finishes

PATTERN ADDS RICHNESS, STYLE, interesting dimension to metal. And now you can protect, and at the same time faithfully mirror a patterned metal, or add distinctive pattern to smooth metal—thanks to M&T sprayed-on, abrasion-resistant, vinyl finishes.

But these thick-film coatings add more than good looks and warmth. They *multiply* service life because they will not chip, corrode, mar, stain or fade. And since the product is coated at the end of the production operation, there are no unsightly raw edges—no problems with welding and forming. Typical use: automotive interiors.

Two types of M&T vinyl finishes are available: one for application to the mill-patterned or perforated metal of your choice; the other for a leather-like texture on smooth metal. Any color, of course. Send for more data.

M&T **coatings and finishes**
METAL & THERMIT CORPORATION
General Offices: Rahway, New Jersey

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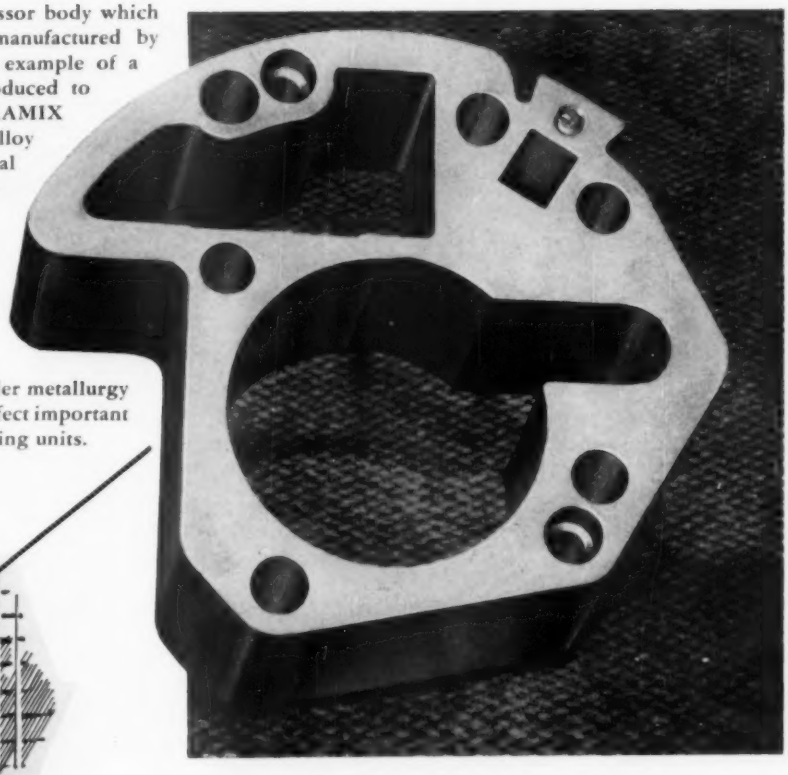
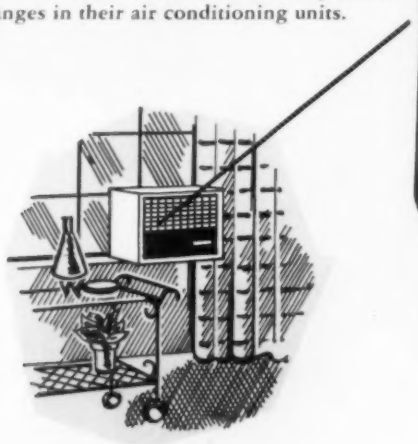
GRAMIX® COMPRESSOR BODY IS VITAL PART IN GENERAL ELECTRIC AIR CONDITIONER . . . this GRAMIX part is a new concept in powder metallurgy techniques . . . engineered to meet requirements of GENERAL ELECTRIC's new compressor design

This large, complex shaped compressor body which is employed in air conditioners manufactured by General Electric is an outstanding example of a GRAMIX part engineered and produced to exacting specifications. As in all GRAMIX products of powder metallurgy, the alloy was created to meet exacting physical properties required in this particular application. Correct briquetting, controlled sintering procedures, precise finishing operations and rigid quality control throughout the manufacturing process assures General Electric uniform, dependable GRAMIX parts. The production of this body as a product of powder metallurgy has also enabled General Electric to effect important design changes in their air conditioning units.





This part is shown full size. Actual weight: 2¼ lbs.

Write today for these helpful engineering manuals. Engineering Bulletin No. 18 covers design and metallurgical requirements and alloy selection of GRAMIX bearings. No. 19 contains facts about GRAMIX Machine Parts and No. 21 contains general information on GRAMIX products from Powder Metallurgy. Get your copies now.

X-274-1

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DIVISION OF THE WICKES CORPORATION, SAGINAW 3, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

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Kanigen®

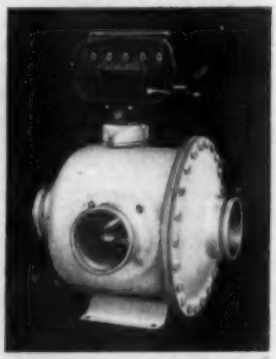
helps keep jet aircraft where the money is ...in the air

Big jet aircraft make money only when they are in the air. Every minute they are earthbound is costly. You just can't take chances on failure of aircraft engines from fuel contamination, or on failure of refueling equipment. That's why those parts of Brodie BiRotor refueling meters and control valves that come in contact with the fuel are chemically plated with KANIGEN nickel alloy.

Brodie BiRotor meters have been used for controlling aircraft refueling for many years, and their internal parts have been KANIGEN-coated ever since this highly accurate method of plating difficult or complicated surfaces was perfected.

Do you have a corrosion or contamination problem? Is it a small part like the Brodie meter housing? Or is it a surface as large as the inside of a 20,000 gallon tank car? Whatever it is, there's a way to solve your problems with KANIGEN chemical nickel plating. Write or phone the nearest General American office.

It pays to plan with General American.



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Another SPEED NUT Savings Story...

62% cost reduction made with **SPEED CLIPS**® on Cramer Posture Chairs

A dozen SPEED CLIPS now do the job of fastening upholstery to the steel seat of Cramer Posture Chairs. Before the switch to Tinnerman SPEED CLIPS, an expensive formed-steel rim was spot-welded to the seat to do this job.

SPEED CLIPS save Cramer at least 46 cents—or 62% of fastening cost—on each chair ... they eliminate the rim-forming and spot-welding operations... permit faster, easier assembly... simplify disassembly if the chair ever needs re-upholstering. Working jointly with Cramer's engineering staff, Tinnerman fastening specialists were able to provide all these advantages without sacrificing product quality.

Assembly costs on your product are likely to benefit greatly, too, if you'll enlist the aid of this Tinnerman team. You can arrange for a free FASTENING ANALYSIS of your product simply by calling in your nearby Tinnerman representative. You'll find him listed in the "Yellow Pages" and in Sweet's PD File under "Fasteners." Or write direct to:

TINNERMAN PRODUCTS, INC.
Dept. 12 • P. O. Box 6688 • Cleveland 1, Ohio

TINNERMAN
Speed Nuts®

FASTEST THING IN FASTENINGS®

CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessories Ltd., Treforest, Wales. FRANCE: Simmonds S. A., 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Mecano Bundy GmbH, Heidelberg.

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OHIO RUBBER

"CUSTOMEERED COMPONENTS BASIC TO INDUSTRY"

STAINLESS STEEL JEWELS
make facsimiles by the million!

OHIO RUBBER can, and regularly does produce 100,000 *identical* rubber parts per day from one set of production tooling. The jewel-like precision of the self registering molds shown above—actual size—is a key factor in ORCO's high speed, high accuracy, continuous molding process.

AUTOMATIC INTEGRATION of processing steps which are usually handled separately eliminates variables—provides precise control for achieving the ultimate in product uniformity. RUBBER PARTS up to 1½" in diameter and 1" in thickness produced by this process are distinguished by uniformity, minimum flash and precision tolerance of ± .003".

QUANTITY REQUIREMENTS involving not less than 500,000 parts proves best for this new process.

"**DO YOU** use small precision molded rubber parts by the million?", if so, the full story of ORCO "CUSTOMEERED" Continuous Molding is yours via free Bulletin CM-100. Send for your copy today to see how custom molded, precision rubber parts can be produced in volume—at less cost. MP-160

ORCO

THE OHIO RUBBER COMPANY

General Office • **WILLOUGHBY, OHIO** • WHitehall 2-0500

A DIVISION OF THE EAGLE PICHER COMPANY

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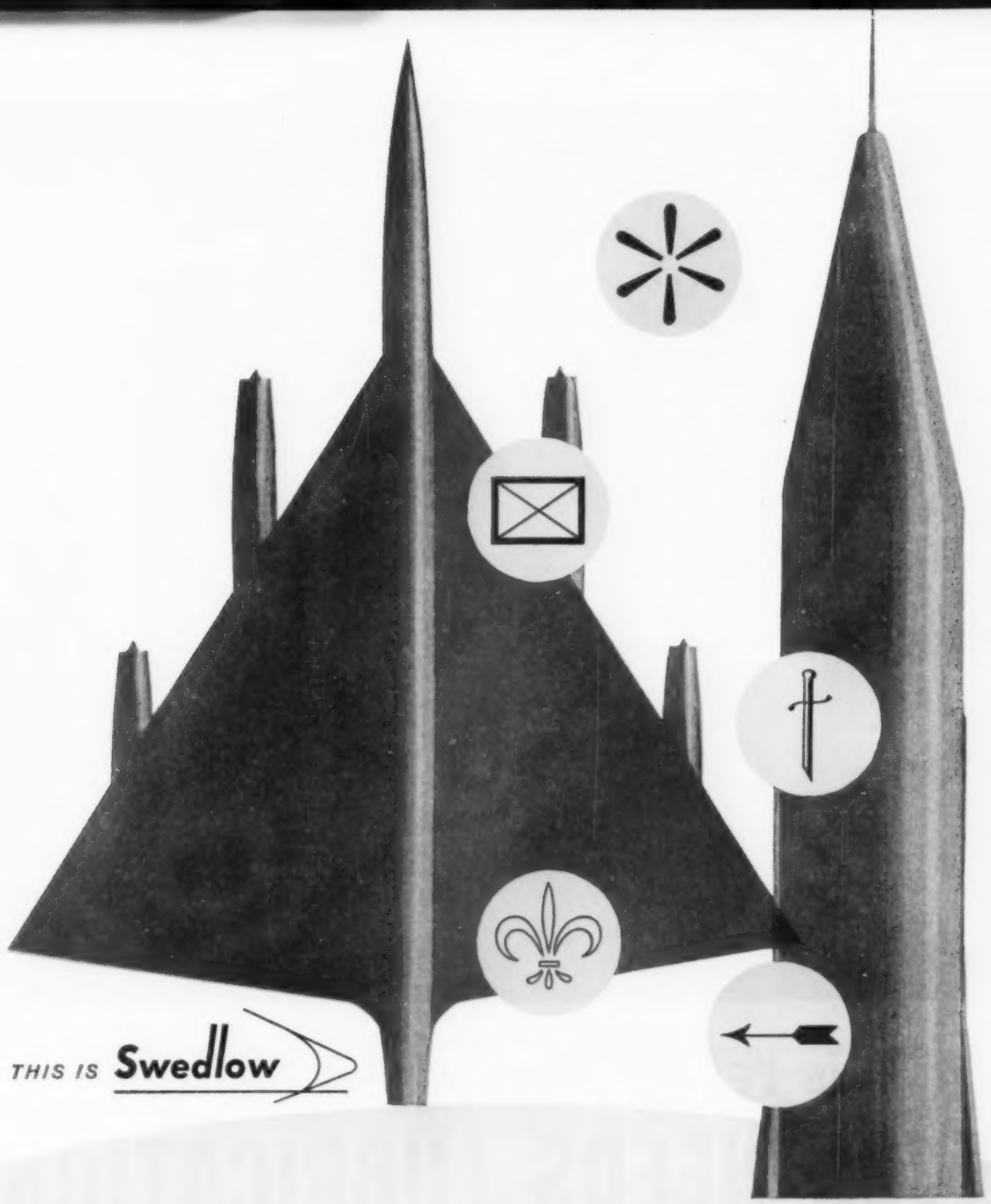


TOMORROW'S MATERIALS TO SHAPE TODAY'S DESIGNS

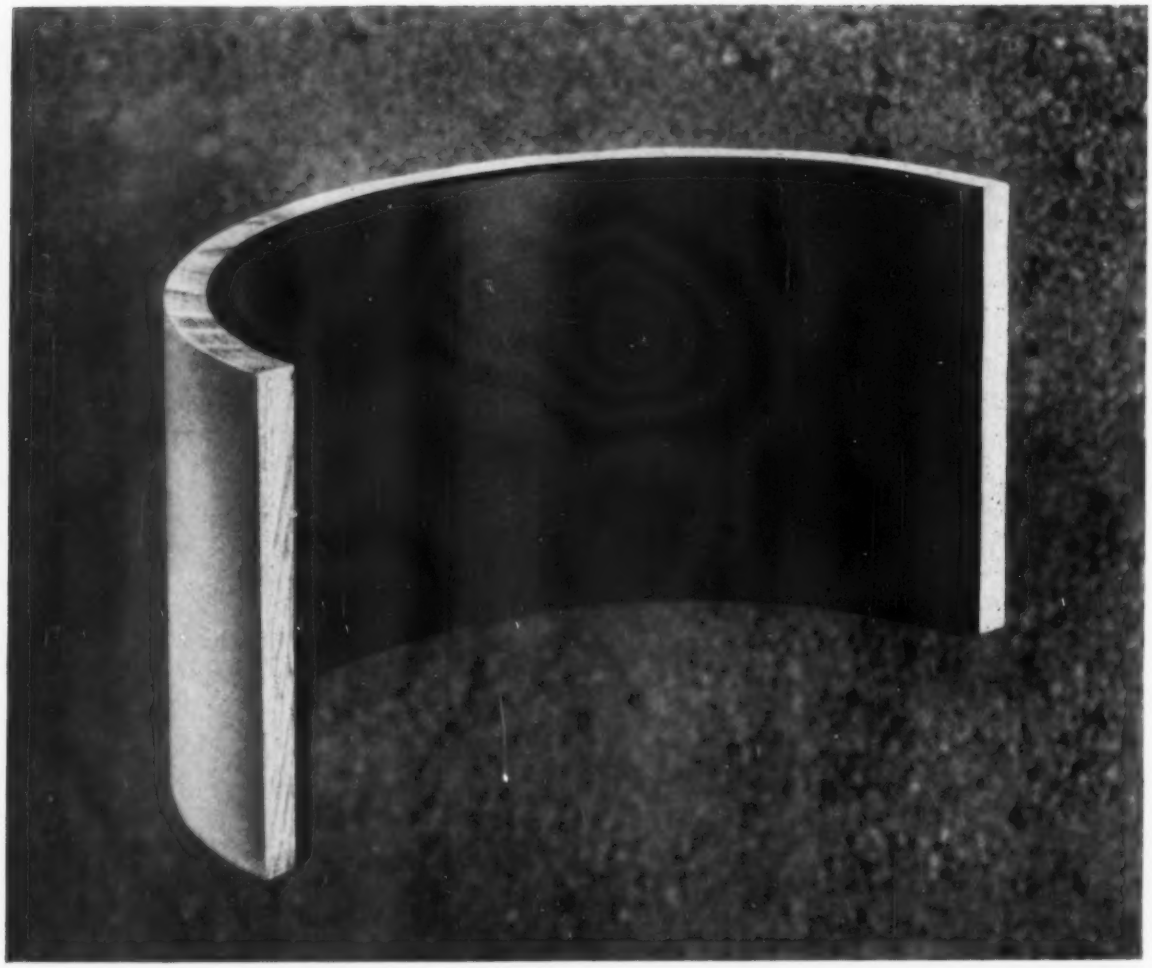
Confidence is a driving force on today's drawing boards. It is the engineer's confidence that the materials he demands can and will be created. Swedlow is unique in its ability to develop and produce materials to meet this demand. These Swedlow developments will help you shape today's designs for tomorrow's air and space vehicles.

Dyna-Therm D-65: flexible flame-resistant coating. Intumescent coating may be painted on in the field. Promises less pad refurbishment time. It cures quickly, protects equipment against heat and blast, up to 6000° F. Remains flexible. Can be scraped away for recoating. **High Temperature reinforced plastic parts and laminates.** Wide variety of combinations to meet exact needs. Flat sheets or compound shapes. Minimum weight and bulk. Heat resistant. For nose cones, exit cones, ducting, shielding. **Metallized heat reflective laminates.** Gold and aluminum coatings increase radiant heat resistance to over 1650°F. Flat sheets or compound shapes. Light, strong; for radiant heat, heat shielding, exhaust heat damping. **Reinforced plastics.** Continuous and press made sheets and molded parts to meet individual requirements. Applications include mechanical, electrical, electronic, phototemplate, decorative, aircraft cargo liners, and many others.

Plastic Glazing. Stretched, as-cast, monolithic and laminated acrylic windows, canopies, windshields, with emphasis on high temperature glazing applications. Optically polished, tough, light weight, resistant to fracture.

WRITE for technical information specifying materials of your interest. Please refer to Dept. 18.

SWEDLOW Inc. / LOS ANGELES 22, CALIFORNIA / YOUNGSTOWN 9, OHIO



This revolutionary new bearing
NEVER NEEDS LUBRICATION!

...Made by St. Regis Panelyte—The St. Regis Panelyte Division has developed an amazing new bearing that actually runs without lubrication *and* with little or no wear! Made of a combination of plastic materials, this new bearing has outstanding strength and moisture resistance plus an extremely low friction co-efficient. This gives the new bearing two special advantages: 1) High resistance to wear (especially in applications of high loads and low speeds), and 2) High resistance to corrosion. Remember, both of these features are now possible *without* lubrication!

A leading eastern paper manufacturer says: *"After eight months of service on our #3 paper machine dryer, there are no visible signs of wear or deterioration on the pair of Panelyte bearings. On the basis of our tests, and their performance with no lubrication, I am recommending the installation of a complete set of these bearings on this machine."*

Get complete details on this revolutionary new "greaseless" bearing. Write today to Panelyte Division, Dept. ME-10, St. Regis Paper Company, 150 East 42nd Street, New York 17, N. Y.

PANELYTE DIVISION **St.Regis** PAPER COMPANY
150 EAST 42nd STREET, NEW YORK 17, N.Y.

For more information, turn to Reader Service card, circle No. 440

New bearings made with TEFLON® last over five times as long as conventional bearings in kiln oven at 370°F.

A paper company's insulation board passes through a kiln oven (370°F.) on rollers supported by 2,000 saddle bearings. Material formerly used cost $2.10 per bearing. Average life: 1½ years. Failure of these bearings frequently caused damage to the steel stub shafts, which then had to be replaced or refinished. Additional cost: estimated at about $0.75 per shaft. Cost per year: well over $1.50 per bearing, plus the additional cost of labor and downtime.

After a thorough program of evaluation, bearings of a filled TEFLON TFE resin were installed. First cost: $3.25 per bearing. After two years of service, the new bearings are still performing perfectly and the shafts show no wear whatsoever. The paper company estimates the service life of the reinforced TEFLON bearings to be at least 10 years. Cost per year: less than $0.33 per bearing.

TEFLON TFE resins offer an exceptionally low coefficient of friction, virtually complete chemical inertness, high-temperature performance up to 500°F. Bearings of TEFLON are usually tailored for increased loads and velocities or high wear resistance by the use of reinforced constructions and filled compositions. And they make possible performance advantages and cost savings like those cited above.

For further information and the new fact-filled booklet "Designing with TEFLON", write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, T26-10, Room 2526, Nemours Building, Wilmington 98, Del. *In Canada*: Du Pont of Canada Limited, P. O. Box 660, Montreal, Quebec.

DU PONT REG. U.S. PAT. OFF.

TEFLON®

FLUOROCARBON RESINS

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

TEFLON is Du Pont's registered trademark for its family of fluorocarbon resins, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resin.

For more information, turn to Reader Service card, circle No. 356

X-A-R ABRASION RESISTANT STEEL

ARMS CUTTING BLADE WITH HARD, TOUGH EDGES

Look for the STEELMARK on the products you buy; place it on the products you sell.

The business end of this land-clearing blade takes a real beating from terrain and timber. It downs brush, trees of all sizes—everything in its path. Shears off stumps at ground level. Piles cut materials into windrows. Drives its stinger through sturdy large trees to split and weaken them. Cuts a wide swath below ground level to build V-type drainage ditches. Works long, hard and fast. ◆ The point of it all? Edges made from $\frac{3}{4}$″ and 1″ X-A-R 15 with a hardness of 360 BHN. X-A-R is the name for tougher, harder alloy steels developed by Great Lakes Steel especially to meet abrasion problems. They're made to work better and last longer wherever materials collide with equipment—as liners, teeth, bars, blades, and plates for example. *Under conditions that commonly wear out equipment in a hurry, X-A-R*

Great Lakes Steel is a division of

X-A-R STEELS ARE AVAILABLE AT THESE STEEL SERVICE CENTERS

Benedict-Miller, Inc. Lyndhurst, New Jersey	Joseph Demsey Co. Cleveland, Ohio	Ducommun Metals & Supply Co. Los Angeles, California	Interstate Steel Co. Evanston, Illinois	Lockhart Iron & Steel Co. Pittsburgh, Pennsylvania

Rome K/G Clearing Blades made of X-A-R—manufactured by Rome Plow Company, Cedartown, Georgia

FOR QUICK, ECONOMICAL LAND CLEARING

outwears any other type of steel. ◆ Close control during heat-treating, quenching and tempering is the secret of low carbon alloy X-A-R steels. And workability is as favorable as their hardness and toughness. Difficult problems, such as welding under cold conditions or extensive flame cutting, are handled well by X-A-R 30. For *extremely* difficult problems, choose X-A-R 15. ◆ X-A-R abrasion resistant steels, supplied in hardnesses from 360-400 BHN (or, by agreement, in lower Brinell hardnesses), are immediately available in ⅛″ to 1″ thicknesses, widths up to 72″ and lengths up to 35′. For complete technical information, write Great Lakes Steel Corporation.

X-A-R
ABRASION RESISTANT STEELS

A PRODUCT OF

GREAT LAKES STEEL
Detroit 29, Michigan

NATIONAL STEEL CORPORATION

Marsh Steel & Aluminum Co.
Kansas City, Missouri

O'Neal Steel, Inc.
Birmingham, Alabama

Salt Lake Hardware Co.
Salt Lake City, Utah

A. C. Leslie & Company, Ltd.
Montreal, Canada

For more information, turn to Reader Service card, circle No. 377

IN BLOW-MOLDING

Hi-fax® Sets the Standard Other Materials Strive to Match

TODAY

TAILORMADE FOR TOUGH JOBS

These nesting Hi-fax bottles carry the water supply for a housetrailer; they were custom-blown to fit available space in trailer interior.

Hi-fax, high-density polyethylene, was the pioneer plastic in thin-wall, blown containers. Hi-fax set the standard . . . was the first material approved by both producers and users of plastic containers for light-duty liquid detergents. While other materials seek to match the Hi-fax standard, Hi-fax remains universally in demand in this first major market for blow-molded high-density polyethylene products.

The same physical and processing properties which enabled Hi-fax to pioneer the breakthrough in detergent bottles have proved equally useful in household chemical, drug and cosmetic containers, and in the development and production of industrial packages of increasingly larger size and scope.

As blow-molding horizons broaden, Hi-fax will continue to lead the way . . . in product testing, market development, and continuous research designed to improve the properties and performance of today's finest blow-molding material.

BIG FAVORITE WITH BIG BRAND NAMES

Hi-fax blown containers are now used by all of the major manufacturers of light-duty liquid detergents.

FOUR VARIATIONS ON A THEME

Avon uses the same Hi-fax container to package both liquid and dry products in its new line of children's cosmetics.

HI-FAX LEADS THE WAY

The larger the part—the greater the need for Hi-fax

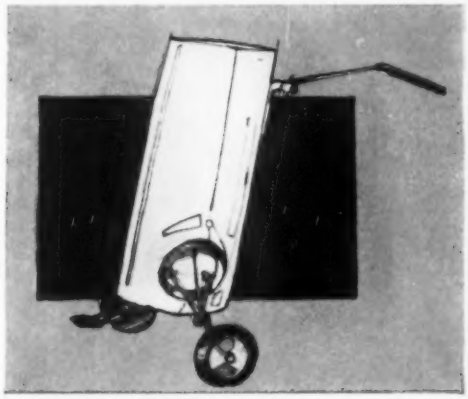
TOMORROW

Growing faster than any other sector of the plastics industry, blow-molding now reaches out into many new markets: industrial packaging, sporting goods, toys, furniture, lighting, and automotive and marine parts. Parts grow larger as improved equipment and processing techniques keep pace with new demands. And still leading the way is Hi-fax, for the larger the part, the greater the need for Hi-fax in terms of superior physical properties and ease of processing.

Hi-fax leads the way, too, in new market developments. Hercules blow-molding experts are ready to help you with design and product planning, in order that you may achieve maximum economies in material and production costs.

Here's a preview of some of the brand new product ideas now possible with Hi-fax and blow-molding:

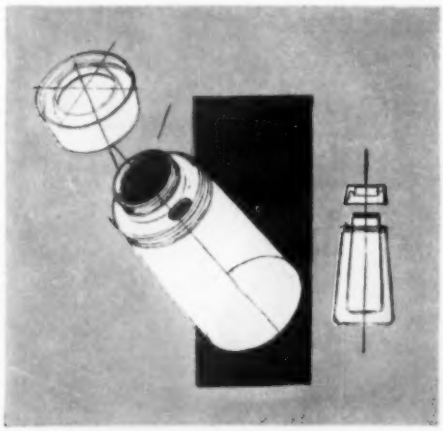
ORIGINAL DESIGNS BY SUNDBERG-FERAR, DETROIT, MICH.



SPORTING GOODS:

This ingenious design for a golf cart combines bag and wheeled-carrier in a single, compact, lightweight unit which can be readily blow-molded with Hi-fax.

Wheels (and tires, if desired) could be blown parts, too. Complete unit would be highly functional, less tiring to use, weather-resistant, and significantly lower in cost.



INDUSTRIAL PACKAGING:

Double-wall bottle solves the packaging problem which arises when two separate ingredients in a product must be shipped separately for mixing immediately prior to use. Blow-molded with Hi-fax, this combination bottle would have the all-important stress-crack resistance so necessary when corrosive products are involved.

TOYS:

Tough, but handsome, too, blow-molded Hi-fax has just what it takes for the design of such modern-styled outdoor toys as this. Both body and wheels could be blown with Hi-fax, resulting in a unit that would be less than half the weight of a metal counterpart, with a finish that would not dent, chip off, rust or corrode.

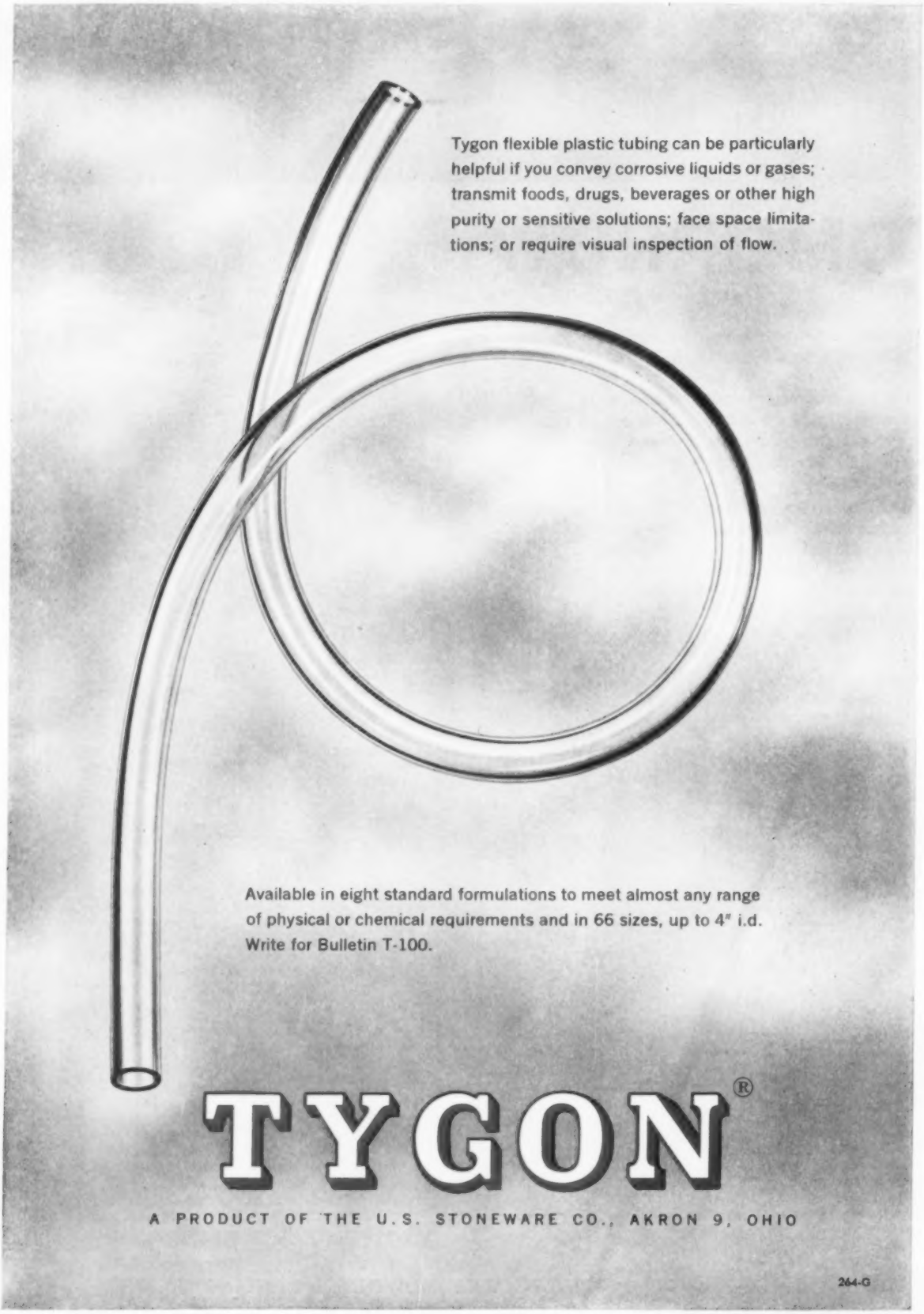
HERCULES

HERCULES POWDER COMPANY
INCORPORATED
Hercules Tower, 910 Market Street, Wilmington 99, Delaware

THREE NEW MATERIALS FOR THE PLASTIC INDUSTRY

HI-FAX® HIGH-DENSITY POLYETHYLENE • PRO-FAX® POLYPROPYLENE • PENTON® CHLORINATED POLYETHER

CP60-15



LOWER YOUR FINISHING COSTS with WALLINGFORD

Bright Annealed Stainless Steel Strip

Conventional steel making is inadequate when you require decorative stainless steel strip with an extra bright finish to pass rigid corrosion tests. "Bright Annealing" is the answer – and Wallingford is the first steel maker to apply this process to its regular production of stainless strip!

How does "Bright Annealing" lower finishing costs? By preventing formation of oxide scales present after conventional annealing and by eliminating the need for further processing which often dulls the finish. Preservation of the bright surface produced by highly polished rolls results in a finish so excellent that users find that buffing time is greatly reduced, affording significant savings.

Superiority in facilities, research and skill enables Wallingford to produce "tonnage on a laboratory basis" and make quality strip available economically.

SEE NEXT PAGE FOR MORE INFORMATION ON BRIGHT ANNEALED STAINLESS STEELS

THE WALLINGFORD STEEL CO.

WALLINGFORD, CONNECTICUT, U.S.A.

COLD ROLLED STRIP: Super Metals, Stainless, Alloy
WELDED TUBES AND PIPE: Super Metals, Stainless, Alloy

COMPLETE AND MAIL REPLY POST CARD TO RECEIVE YOUR COPY OF OUR NEW FOLDER ON STAINLESS STEEL STRIP, "TONNAGE ON A LABORATORY BASIS"

☐ Please send me your "Tonnage On A Laboratory Basis" Folder (Form No. G-1333).

☐ Have your representative call to discuss my finishing requirements.

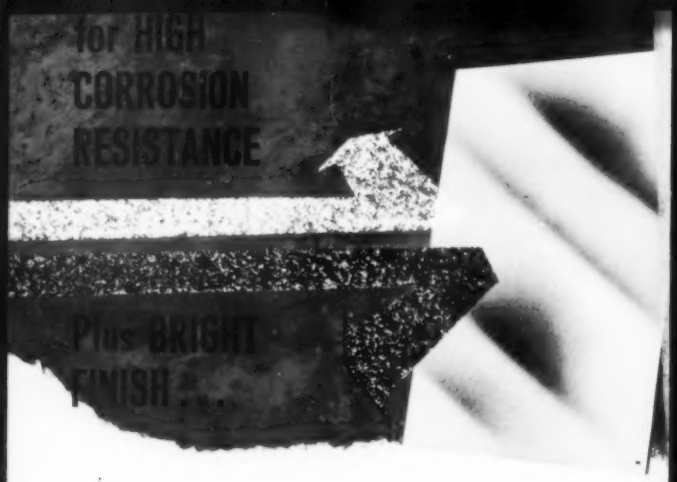
Name_____ Title_____

Firm_____

Street_____

City_____ Zone_____ State_____

**JUST COMPLETE ABOVE AND MAIL—
NO ADDRESSING OR POSTAGE REQUIRED.**



WALLINGFORD

Bright Annealed Stainless Steel Strip

Stainless steel derives its resistance to corrosion from the presence of chromium, so any depletion of chromium during processing must be avoided.

Because of Wallingford's success in this area, Wallingford Stainless Steel passes even the most rigid corrosion tests set up by leading manufacturers. Exceptional corrosion resistance is of prime importance when the stainless steel is to be used for decorative purposes and may be exposed to weather, salt water, or other corrosive elements.

In producing this stainless steel strip, Wallingford employs bright annealing. Result? Reduced customer buffing costs PLUS corrosion resistance and a bright finish never before attained!

Whether your problem is brightness of finish or the degree of corrosion resistance, Wallingford can supply stainless steel strip that will satisfy.

> Widths from 0.150" to 27". Thicknesses down to .0005". Extremely close tolerances are maintained.

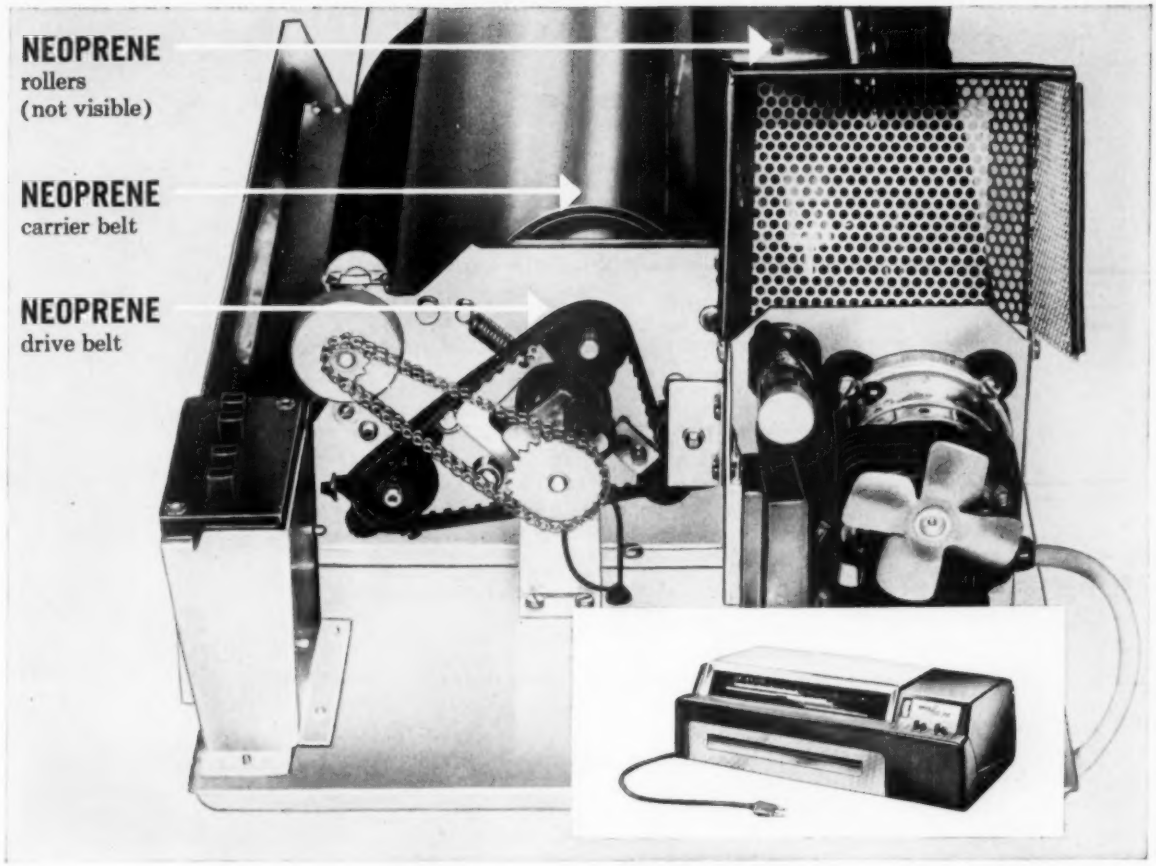
COMPLETE REVERSE SIDE OF REPLY CARD BELOW AND MAIL TO RECEIVE NEW STAINLESS STEEL STRIP FOLDER, "TONNAGE ON A LABORATORY BASIS"

FIRST CLASS
PERMIT NO. 116
Wallingford, Conn.

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed in the United States
— POSTAGE WILL BE PAID BY —

THE WALLINGFORD STEEL CO.
Wallingford, Connecticut

MDE



In new photocopier...

NEOPRENE PARTS GIVE "BEST ALL-AROUND PERFORMANCE"

In designing the new "Auto Stat" photocopy machine, engineers at the American Photocopy Equipment Company, Evanston, Illinois, specified neoprene *exclusively* where rubber parts were required. Included are such key components as: printer belt, carrier belt, drive belt, processor rolls and paper transport rolls.

"Neoprene gave us the best all-around performance of any material we tested," reports an Apeco engineer. "We found, for example, that it's highly resistant to the corrosive action of caustic developer chemicals. It withstands ozone exposure without cracking or crazing. In rollers and wheels, neoprene resists compression set, and in belting it holds its size and shape."

No other general purpose rubber can equal neoprene's *balanced combination* of properties, or match its resistance to so many deteriorating factors. Neoprene assures longer service life for equipment because parts *stay* lively and resilient over years of operation. What's more, parts made of neoprene will not support combustion.

If you'd like to learn more about the many ways neoprene is solving design problems in everything from household appliances to equipment for business and industry, write for a free copy of "An Engineering Guide to the Du Pont Elastomers." E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Department MDE-10, Wilmington 98, Delaware.

DU PONT
REG. U. S. PAT. OFF.

SYNTHETIC RUBBER

NEOPRENE HYPALON® VITON® ADIPRENE®

Better Things for Better Living . . . *through Chemistry*

For more information, circle No. 462

For more information, turn to Reader Service card, circle No. 354

Weld failures cut 89% using vacuum-melted filler wire

[*Weld tests on alloy steel wire used in missile applications revealed nine times as many failures with air-melted wire as with Cannon-Muskegon vacuum-melted wire.*] [*Superior to consumable-electrode melting, Cannon-Muskegon vacuum-induction melting greatly reduces gas levels (nitrogen less than 25 ppm, oxygen less than 25 ppm, hydrogen less than 5 ppm). Combined sulphur and phosphorus run less than .015%.*]

[*These remarkably low gas and impurity levels can be most efficiently obtained with Cannon-Muskegon vacuum-induction melting. You are invited to write Cannon-Muskegon for further details.*]

☛ [*Among test samples prepared from air-melted wire, 18 out of 32 failed at the weld.*]

☛ [*Among similar samples prepared from the vacuum-melted wire of the same grade, only two out of 32 bars failed at the weld.*]

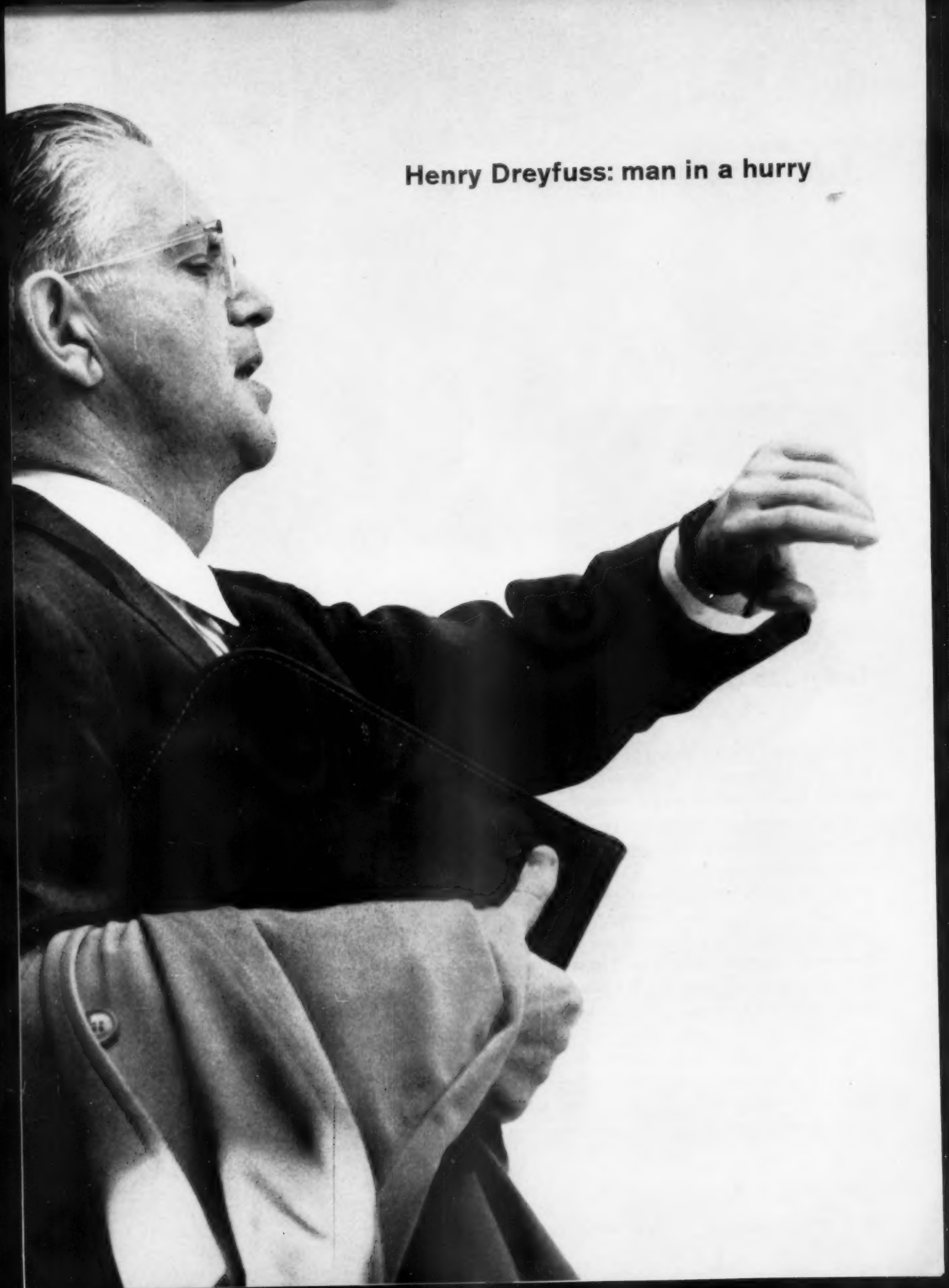
[*Different alloys of Cannon-Muskegon vacuum-melted welding wire are available in sizes from 1/32" to 1/4", in 36" cut lengths, or in 10 or 25-lb. spools packed in airtight Argon-filled steel containers.*] 

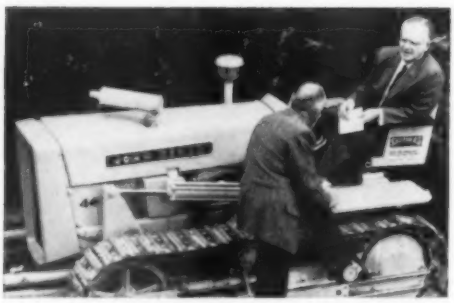
ULTRAMET
VACUUM ALLOYS

CANNON-MUSKEGON CORPORATION

Metallurgical Specialists • 2873 Lincoln Street • Muskegon, Michigan

For more information, turn to Reader Service card, circle No. 339


Henry Dreyfuss: man in a hurry



Dreyfuss talks design

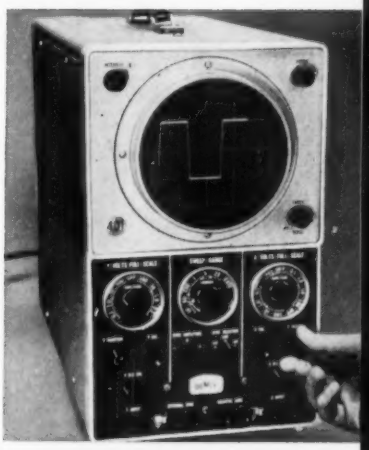
If you could get Henry Dreyfuss to sit still long enough for a caricature, the drawing would inevitably show him with his coat half on and briefcase in hand. Most likely, he would be on his way to the airport. He's on the East Coast a third of his time, on the West Coast a third, and the other third in between.

Henry Dreyfuss has been busy ever since he gave up scenery design in the late Twenties and helped pioneer the business that is now called industrial design. In the early days, he gave a new look to everything from hinges to pianos, cigarette lighters to tractors. Today he can look back on a career of redesigning vacuum cleaners and gas stations, bowling alleys and ship interiors, typewriters and dental equipment, magazine formats and military strategy rooms, plumbing fixtures and the Nike missile launcher.

But Henry Dreyfuss is not one to look back. There are designs on his boards today that will influence our lives twenty years from now. "Time," he says, "is one of the designer's big problems. A design assignment is often three years in development. The item may not be on the market for another three to ten years. After it's introduced it will be in use for any number of years. In order to design that far ahead, our ideas have to be fresh, advanced and sprightly. It is a challenge to have to think as far ahead as we do."

One thing that goes a long way is the Henry Dreyfuss design credo, and it is all about people. "It says in effect," Dreyfuss states, "that the item is going to be ridden in, sat on, looked at, talked into, operated or in some way used by people. If the point of contact between the product and people causes friction, we have failed.

"On the other hand, if people are made safer, more comfortable, more eager to purchase, more efficient, or



just plain happier—we have succeeded." And succeed Dreyfuss does, by following this yardstick for effective industrial design: 1. Safety and convenience of use. 2. Ease of maintenance. 3. Cost, including tooling, production and distribution. 4. Sales appeal. 5. Appearance.

Selection of the right material for the job plays an important role in satisfying each of the five requirements. As a matter of ethics and sheer common sense, Henry Dreyfuss, like any member of the American Society of Industrial Designers, will not endorse any one material. "We have worked with all materials. What we want is the material that is right for the job. We look for the material that combines reasonable cost with the ability to be fabricated economically, and at the same time will give the product the built-in quality and durability it needs to sell well." With no-nonsense requirements like that, it is not surprising that a great many Dreyfuss-designed products use steel in one way or another.

Steel has strength, integrity and honesty. Steel is what the designer is apt to call a 'natural.' Dreyfuss feels that the public's image of steel depends largely on the product itself. A massive steel vault door conjures up an image of strength, imperviousness. Stainless Steel tableware suggests style and modernity. Steel curtain wall panels give buildings the look of tomorrow.

The moral is this: steel has been with us for ages, yet it is the modern metal, the metal of the future. Its enduring modernity will continue to be recognized, and used, by designers like Henry Dreyfuss.

(turn the page for a new look at steel)

designing with USS High Strength Steels

Good design goes beyond material selection. Once the choice has been made, the designer's job is to take full advantage of the material's properties. Few materials offer designers as much opportunity as high strength steels.

COR-TEN Steel was developed by U.S. Steel and first used in 1933.

USS COR-TEN Steel is a name that has become a byword in design circles. It is a time-tested, high-strength low-alloy steel. Structural designers welcomed COR-TEN Steel because it allowed them to pare dead weight and to lower maintenance costs. As structures, mobile equipment and machinery got bigger and bigger, dead weight became more of a problem. Even when weight could be shaved without stress problems, durability suffered. This high strength steel answered both problems.

Dead weight in stationary structures is costly; in mobile equipment dead weight requires more power to move.

USS High Strength Steels' yield points are all 50,000 psi min. compared to 33,000 psi for structural carbon steel.

Strength did it. COR-TEN brand and other USS High Strength Steels have a 50% higher yield point than structural carbon steel. They permit as much as 33% weight reduction. They have superior resistance to atmospheric corrosion and abrasion, so there is little reason to overdesign. Their fatigue and impact properties are excellent. Here is a quick look at three well-known USS High Strength Steels:

Send for the manual described at the right for a comprehensive guide on how to design with high strength steels.

USS COR-TEN Steel has a yield point 50% greater than structural carbon steel, has four to six times its resistance to atmospheric corrosion. It is used to do any one of these three things: 1) in slimmer sections to cut weight at no strength loss; 2) in equal sections to increase load-carrying capacity, cut maintenance and lengthen life; and 3) any number of combinations of 1 and 2. COR-TEN Steel also has greatly superior paint adherence and is used where a longer interval between repainting is wanted.

USS TRI-TEN Steel, with its 50% higher yield point than structural carbon steel, has superior notch toughness at low temperatures and keeps rugged equipment operating even in sub-zero weather. Its high endurance limit makes TRI-TEN Steel ideal for mobile equipment that must take repeated loading and reversals of stress. It is a natural for welded structures and bridges.

MAN-TEN Steel costs only about 20% more than structural carbon steel; TRI-TEN Steel about 36% more, and COR-TEN Steel 42% more.

USS MAN-TEN Steel also has a 50% higher yield point than structural carbon steel, and is the low-cost member of the family. Weight reduction as little as 17% with MAN-TEN Steel will save money on material cost alone. MAN-TEN Steel is a tough, durable steel and widely used in earthmoving equipment, truck frames, material handling apparatus and riveted bridges.

High strength steels represent but a few of the over 3000 grades of steel in existence today. United States Steel makes a complete line of high strength steels, as well as constructional alloy, stainless and carbon steels. Bring your design problems to us. United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

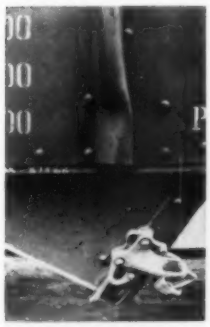
USS, COR-TEN, MAN-TEN and TRI-TEN are registered trademarks.

USS United States Steel

Cranes have to operate in all-weather temperatures and are subject to stress and shock. That's why many of them are made of tough TRI-TEN Steel.

Light standards stay good looking for years because of COR-TEN Steel's outstanding atmospheric corrosion resistance. Paint life is extended. Slim design is made possible by COR-TEN Steel's strength.

TRI-TEN Steel has cut weight and cost of dozens of major bridges. In the bridge shown here, TRI-TEN Steel saved a quarter of a million dollars.



One of the first applications of COR-TEN Steel was in hopper cars for weight reduction and longer life. Today, use of COR-TEN Steel can save hundreds of dollars over the life of a car.

MAN-TEN Steel, used in truck frames and body members, reduces dead weight and increases payload.

The LPG cylinder business uses considerable amounts of MAN-TEN Steel because of its strength, cost and ease of fabrication to lighten the weight.

This mark tells you a product is made of modern, dependable Steel.

Here's a book that is in the hands of thousands of engineers and designers. It is your guide to the design of lighter, stronger equipment and structures.

design manual for high strength steels

TABLE OF CONTENTS

United States Steel
Room 6150
525 William Penn Place
Pittsburgh 30, Pa.

Please send me "Design Manual for High Strength Steels"

Name _____

Title _____

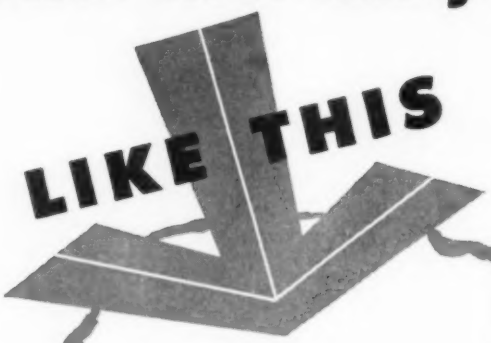
Company _____

Address _____

City _____ Zone ____ State _____

Need Refractory Metals In A Hurry?

FANSTEEL'S NEW WAREHOUSE CAN SHIP Within Hours!



Rocket engine prototype:
an unexpected change with tests due to start in 3 days . . . a call to Fansteel . . . warehouse shipped tungsten sheet within 4 hours, delivery to customer next afternoon.

Chemical pilot plant:
new construction order for 36" tapered condensers, 1"x18" single tube bayonet heaters, assorted tantalum screws shipped complete same day received.

Electronic tube manufacturer:
urgent need for 7 molybdenum crucibles for new facilities . . . Fansteel warehouse shipped same day.

Electrical Appliances:
.025" molybdenum wire needed rush . . . ordered in late afternoon . . . Fansteel shipped following morning . . . delivery ahead of time.

Now it's easy for you to meet or beat production deadlines, prototype or pilot plant completion dates. At right are just a few examples of the new Fansteel warehouse service which hundreds of manufacturers have already used.

OFF-THE-SHELF DELIVERY ON:

Tantalum Tungsten Molybdenum Columbium Refractory Metal Alloys	wire, rod, foil sheet, plate
Tantalum Chemical Plant Equipment	bayonet heaters, heat exchangers, coils, thermowells, tubing

Also many other products, plus complete processing service, technical assistance.

Write to Metals and Fabrication Division for your copy of the Fansteel Warehouse Price and Stock List . . . or contact your local Fansteel representative.

FANSTEEL HIGH TEMPERATURE METALS

FANSTEEL METALLURGICAL CORPORATION
NORTH CHICAGO, ILLINOIS, U.S.A.

K606

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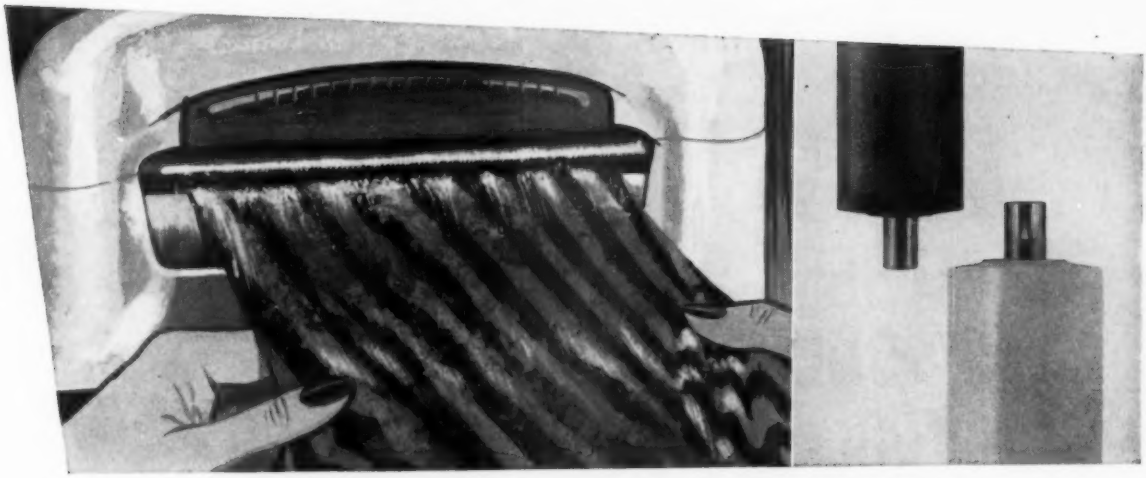

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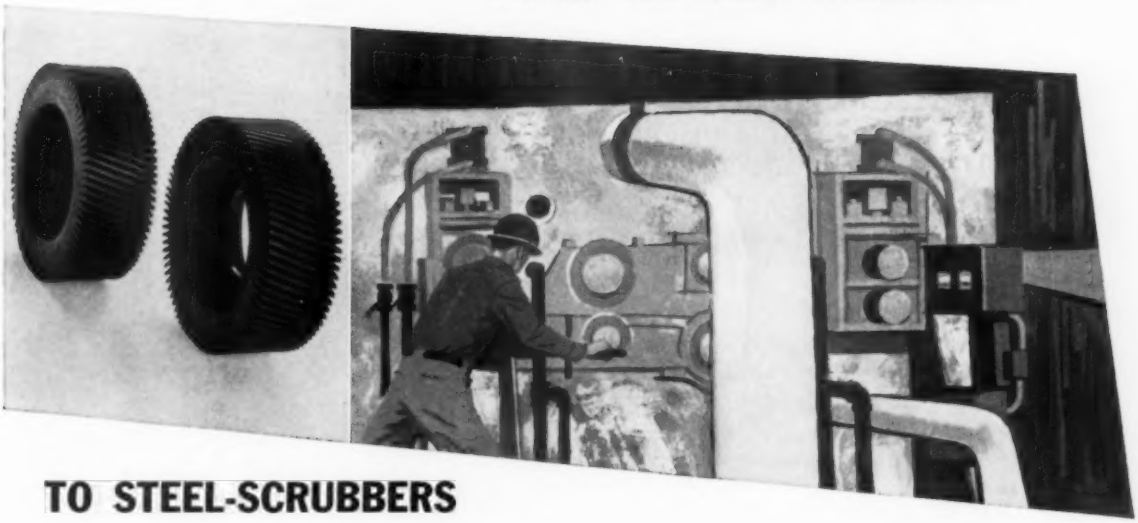

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Ameripol Micro-Black sales climb

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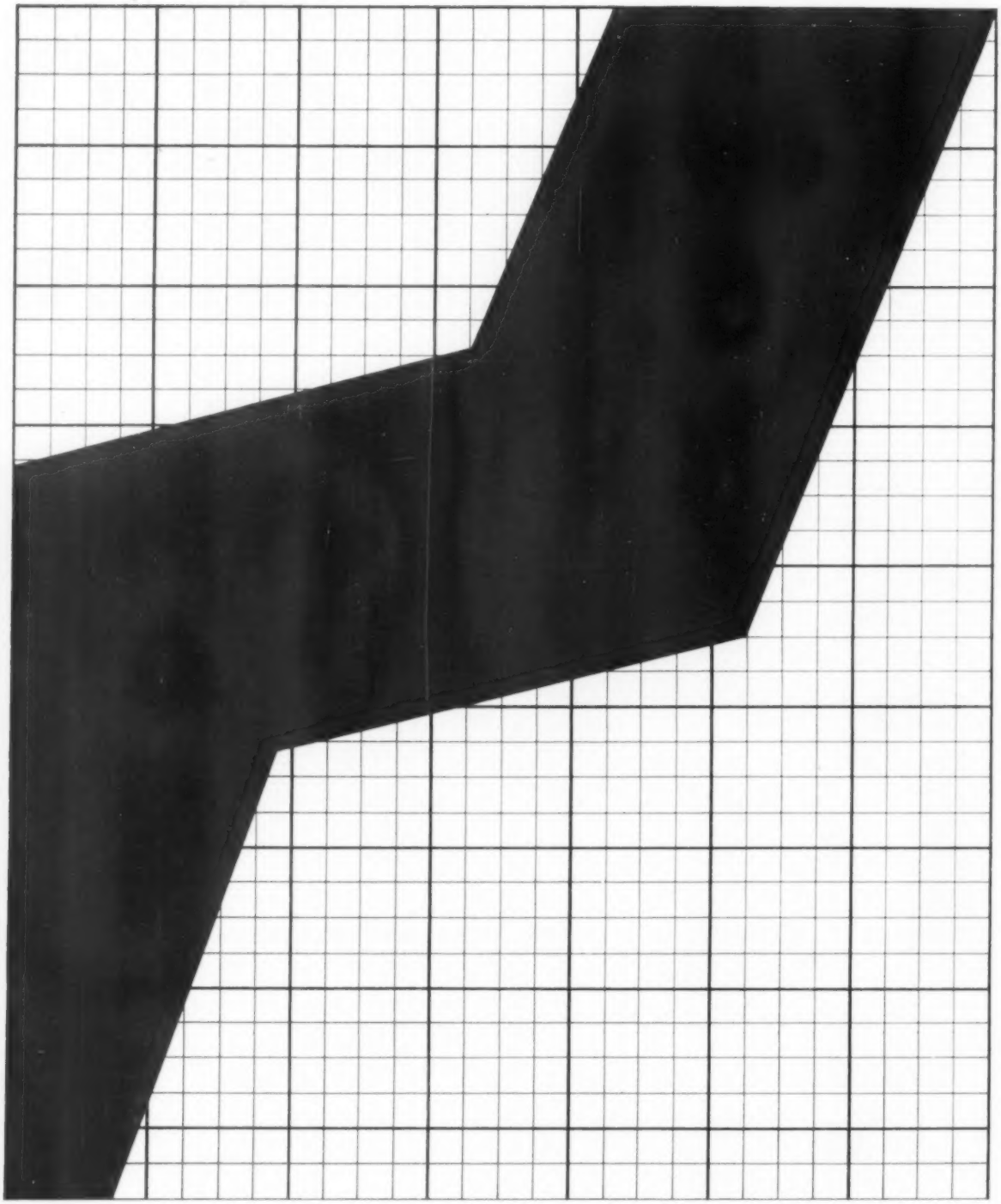

more than 1400% in just 18 months

Users report 21 ways to improve rubber products, save time and money with Ameripol Micro-Black masterbatch

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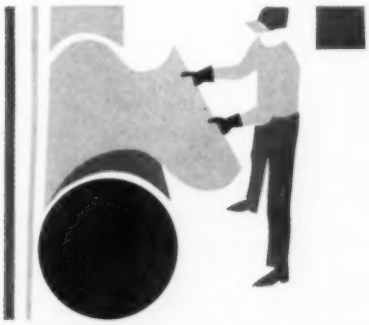
Now, here are the 21 ways Micro-Black has proven its ability to improve rubber products and save time and money:

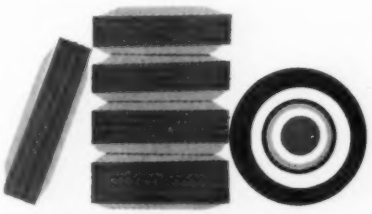


IN PRODUCTION, Ameripol Micro-Black . . .

1. Eliminates one weighing operation.
2. Eliminates one milling operation.
3. Shortens other mixing operations.
4. Releases mixing equipment for other uses.
5. Lowers power consumption.

IN STORAGE AND HANDLING, Ameripol Micro-Black . . .

6. Is packaged in thirty-bale units for faster handling.
7. Does not cold flow.
8. Permits stocking a semi-processed material.
9. Is easy to warehouse.
10. Eliminates in-plant storage of carbon black.
11. Ends carbon black mess and clean-up expense.
12. Is readily available from two strategic shipping points.



IN THE END PRODUCT, Ameripol Micro-Black . . .

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14. Provides a uniform standard of quality control.
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16. Adds substantially to abrasion resistance.
17. Prevents damage to rubber as caused by high-viscosity milling.
18. Provides a stronger bond between rubber and carbon black.
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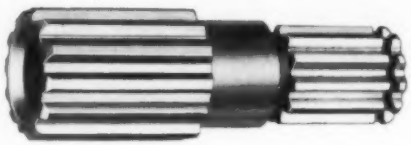

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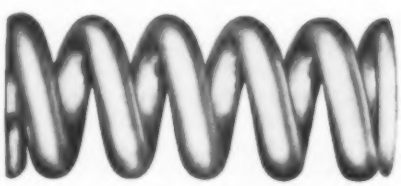

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ENGINEERING & DESIGN

...AT A GLANCE

Copper-containing steels have better fatigue properties when heat treated to high tensile strengths than similar steels without copper. Studies show that the amount of copper used is critical, with 1.3% by weight giving optimum strength when low tempering temperatures are used.

Source: National Bureau of Standards, Dept. of Commerce, Washington 25, D.C.

Improved methods for evaluating the properties of materials under conditions of extreme heat and cold are promised with the development of two new devices. One device is a special type of refrigerator that is said to permit the accurate measurement of tensile strengths at temperatures near absolute zero. The other device is an electric arc heater that is capable of supplying a stream of gas at temperatures as high as 20,000 F and at pressures as high as 15,000 psi—duplicating the extreme conditions met by space vehicles upon re-entry into the earth's atmosphere.

Sources: Arthur D. Little, Inc., Acorn Park, Cambridge 40, Mass. (refrigerator), and Westinghouse Electric Corp., Box 2278, Pittsburgh 30 (heater).

It may be more economical to paint thermoplastic parts that have been molded in neutral colored or reprocessed plastics rather than mold in color. A recent producer's study shows that this is especially true in applications where small quantities of materials and special colors are involved. A good paint to use is butyrate-acrylic.

Source: T. E. Hayden, Bee Chemical Co., 12933 S. Stony Island Ave., Chicago 33.

Inconel is an excellent construction material for the steam generating system of pressurized water nuclear power plants, a recent study shows. In the application, Inconel is exposed on one side to primary reactor water (i.e., water flowing past radioactive fuel elements) and on the other side to secondary boiler water.

Source: W. E. Berry, Battelle Memorial Inst., Corrosion Research Div., 505 King Ave., Columbus 1, Ohio.

A good way to find defects in electroplates and other coatings is electrographic printing: it provides accurate and permanent images of any defect, and permits prompt comparisons with existing visual records. The coated side of a specimen is placed against photographic paper and an electrical charge applied. Cations from the basis metal pass through any cracks or pores in the coating and form an image of the defect on the photographic paper.

Source: H. R. Miller and E. B. Friedl, Battelle Memorial Inst., 505 King Ave., Columbus 1, Ohio.

Polystyrene is the best material to use in optical systems exposed to intense gamma radiation or x-rays, according to recent research. Tests show that commercial-grade glass, and acrylic, allyl carbonate and polyvinyl acetate plastics have losses in light transmittance and are discolored after exposure to intense x-rays.

Source: Rpt. PB 145013, Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D.C.

A transparent oxide film may solve the age-old tarnishing problem associated with copper. Recent research shows that it may be possible to produce a protective oxide film by heating copper in atmospheres that are oxidizing to minor alloying elements and reducing to copper.

Source: C. H. Moore, Copper Products Development Assn., Inc., 50 W. Gay St., Columbus 15, Ohio.

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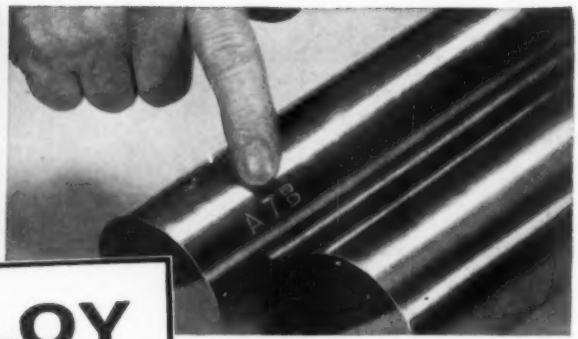

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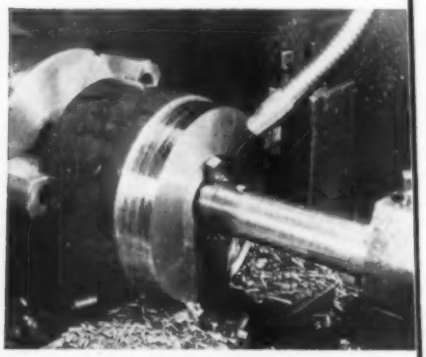

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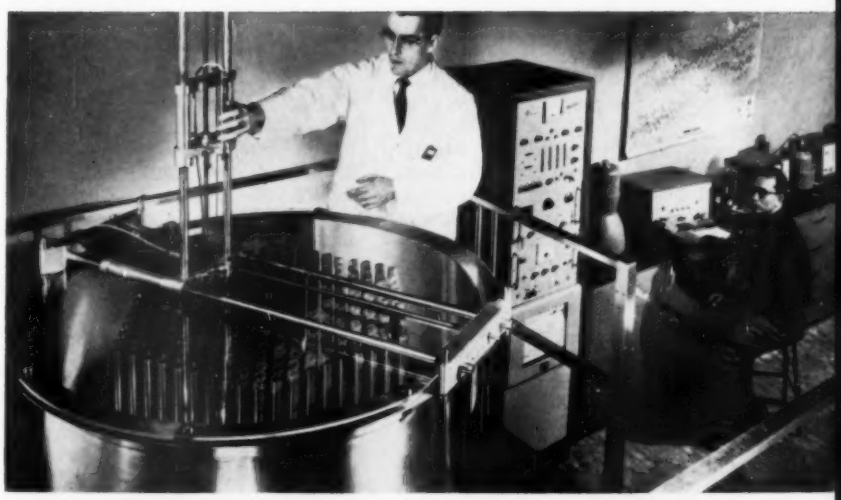
Materials for Portable Nuclear Reactors

Reactors designed for research and training purposes pose special problems in materials selection. Both cost and weight must be minimized. Here is a look at current practice in fuels, controls, moderators, reflectors and shielding.

by Edward J. Mullarkey,
Technical Director,
Lead Industries Assn.



***NC 9000 reactor** core consists of 275 aluminum tubes 1.25 in. in dia by 58 in. long arranged in hexagonal pattern and supported by two grid plates (not shown). The tubes are designed to hold 1 in. dia by 8 in. long natural uranium slugs whose total weight is 5500 lb. Uranium is made available to schools under AEC assistance program.*

■ Portable research and training reactors are widely used for instruction and orientation with nuclear physics and to explain the principles of reactor design and operation. They are also especially useful for radiation detection and health physics investigations, and in moderate-level tracer research.

Such reactors differ greatly in design from larger reactors. They are moderately priced and low powered. Also, shipment, installation, operation and maintenance are relatively simple, safe and inexpensive.

Like other reactors, portable reactors involve many compromises in materials selection. Unfortunately, nuclear materials do not always have good structural properties, and are often heavy, massive and expensive.

1. Fuel materials

Fuels can be liquid or solid

The fuel materials used in portable reactors can be liquid or solid and are usually enriched with fissionable U-235 so as to reduce size.

Homogeneous reactors use liquid or solution-type fuels, or fuel uniformly divided and dispersed in a solid moderator. Advanced reactors such as L-77 (Atomics International) and AGN 201 and AGN 211 (both Aerojet-General Nucleonics) are homogeneous reactors and provide the only practical experience with homogeneous systems to date.

Heterogeneous reactors use seperate fuel and moderator elements and are typified by the TRR (Nuclear Development Corp. of America) and NC 9000 (Nuclear Chicago) reactors. Heterogeneous portable reactors commonly use a so-called "canned" fuel element which, at the present state of the art, is giving ground to more efficient designs.

Design for minimum critical mass

The reaction rate and flux desired in a reactor fixes four factors: 1) the number of fuel atoms required per unit volume, 2) the ratio of fuel atoms to the atoms in the structure, 3) choice of coolant and moderator, and 4) operating temperature. Also, nuclear physics dictates the spatial distribution of fuel atoms within the core and, in the case of heterogeneous reactors, provides a first approximation of the shape and arrangement of fuel elements.

In designing a fuel system it is desirable to approach the minimum critical mass with a nonuniform fuel distribution arrangement. This approach, combined with judicious moderator and reflector selection, reduces fuel loading. And, from a safety standpoint, it insures that any rearrangement of the fuel will decrease reactivity.

Nuclear Fundamentals of Portable Reactors

Portable reactors are thermal type

Nuclear reactors are classified by their predominant neutron energy spectrum and fall into three categories: thermal, intermediate and fast. Portable research and training reactors are thermal-type reactors and incorporate a moderator and reflector. The moderator slows neutrons released in the fission reaction to thermal energies where the probability for fission is great. As its name implies, a reflector returns to the core neutrons that would otherwise leak out of the system. The reflector permits a reduction in fuel requirements, thus reducing the cost of both fuel and construction materials.

Subcritical vs critical

Depending on their sustaining features, portable reactors are either subcritical or critical.

An important factor in this relation is the effective multiplication factor, k—the ratio of the average number of neutrons produced by fission in each generation to the corresponding number of neutrons absorbed in the fuel, moderator, etc., or leaking out.

If $k = 1$, the chain reaction is stationary and self-sustaining, or critical. If $k < 1$ the chain is not self-sustaining and is subcritical (without an extraneous neutron source the chain reaction cannot be maintained). If $k > 1$, the chain is divergent and the system is supercritical.

The k values for portable research and training reactors are equal to or less than 1. Flux is confined to 10^7 to 10^{10} n per sq cm-sec to avoid danger of overexposure and needless expense.

Effective multiplication is made up of two factors: the infinite multiplication factor $k\infty$ and the nonleakage probability. The $k\infty$ factor is the ratio of average number of neutrons produced in each generation to the average number of corresponding neutrons absorbed. Nonleakage probability, on the other hand, is a measure of the probability that neutrons will not leak out but will remain until absorbed to cause fission.

Some neutron leakage is desirable for research and training purposes. Extent of leakage depends on two factors: The first is the dimensions of the reactor. The second is the distance a neutron travels from its birth as a fission neutron to its ultimate absorption in an experiment. This distance is related to a quantity called the migration length.

Thermal utilization should be high

For every neutron absorbed by a fuel atom, 2.08 neutrons are produced. Of these, one must be captured by another fuel atom to sustain the reaction. Thus, at the most only 1.08 neutrons are available for experimentation. Also, some will be captured in the moderator and structural materials in the fuel region. The ratio of the number of captures in fuel to the number of captures in the fuel-plus-moderator-and-structure is the thermal utilization, f.

Since one of the 2.08 neutrons is captured in a fuel atom, $1/f$ represents the total number captured in the fuel region and $2.08—1/f$ the number that leak out of the fuel region. Thus, if f is 1 there will be 1.08 neutrons per U^{235} capture available for experimentation. This is equivalent to a maximum value of 3.3×10^{16} neutrons per sec absorbed in experiments for each megawatt of thermal power. This maximum figure is a constant independent of reactor design. Thus, to make a research and training reactor efficient the thermal utilization in the fuel region should be high and experimental facilities should be properly placed to receive neutrons leaking out.

Consider the effects of fuel growth

Solid fuels have a tendency to grow in preferential directions when irradiated. (Since low powered reactors produce low heat levels we can neglect the effects of heat transfer.) This growth is caused by elemental changes in the fuel as well as changes in chemical and structural properties. As burn-up proceeds, each fissioning atom is replaced by two fission product atoms (some existing as gases) which generally have a greater volume than the parent material.

The above effects tend to cause expansions and stresses in the fuel element and have to be accommodated lest they cause distortion. Distortion can affect coolant flow or the distribution of the moderator within the core matrix. And the resulting hot spots and disrupted flux patterns can result in shutdowns and costly repairs. Under such circumstances it is prudent to approach core design with the utmost feeling for safety.

Special liquid fuel problems

In principle, homogeneous reactors are based on the operational characteristics of the KEWB (Kinetic Experiment on Water Boilers) design. Unlike solid fuels, liquid fuels can be changed or removed easily and are free of the effects of anisotropy. Naturally, the materials retaining the fuels must resist corrosion and radiolytic decomposition. Because of its proper combination of structural, nuclear and corrosion properties, stainless steel is generally used in contact with aqueous uranyl sulfate fuel suspensions. Such suspensions should be completely free of harmful chlorides.

The problem of radiolysis with the water moderator in homogeneous reactors is only slight, since the free radicals that form tend to recombine and establish equilibrium. The L-77 reactor, for example, contains a recombiner unit containing platinized alu-

mina catalyst pellets which recombine circulating hydrogen and oxygen gases to form water. The equilibrium of the water depends on impurities and the fuel solute which can create an excess of either peroxide or hydrogen. An excess of hydrogen tends to suppress decomposition almost completely. Conversely, an excess of peroxide tends to increase decomposition.

The L-77 reactor also contains an overflow chamber to offset possible fuel solution expansion caused by bubble formation. If expansion is great enough it will force some of the fuel solution into the overflow chamber, thus making the reactor subcritical (k becomes less than 1) and producing an automatic shutdown.

Hot gases can be beneficial

The gases generated in a reactor can be beneficial. For example, in a liquid fuel reactor such as the L-77, "hot" gas can be transported to remote experimental apparatus, giving the unit great versatility. About 10 curies (15 to 20% of the total) of volatile fission product activity is present in the L-77 under equilibrium conditions.

Unlike gases in the L-77 design, however, the gases generated in the AGN 211 reactor are not beneficial and cannot be used for other gainful purposes. In the AGN 211 core there are about 45 curies of radioactive gases present at steady-state operation. About one-third of the gas is harmful iodine-131. (Maximum permissible concentration for iodine-131 is 5×10^{-9} curies per ml or 5×10^{-9} curies per cu m of air.) However, this quantity of activity should cause no trouble. In order to be hazardous the iodine must first diffuse out of the uranium oxide particles, through the polyethylene element and its coating, and then escape from the water. This likelihood is extremely small.

Life of polyethylene core materials

Polyethylene is somewhat more radiation resistant than water and tends to trap any decomposition products or gases occurring in the matrix. Radiation damage manifests itself in reduced density and loss of hydrogen from the polyethylene after exposures of about one week at a flux of 10^{12} n per cm^2-sec. A flux time (nvt) extrapolation indicates that the core life of the material would be more than 10,000 hr based on an average continuous power of 100 w.

2. Control element materials

Reactors are controlled by changing the nuclear reactivity of the core. Change in positive reactivity can be made by moving the fuel, or by changing the moderator density or core leakage.

In the case of a reactor like TRR, simply changing the deuterium oxide level of the heavy water moderator permits fine "tuning" of the excess reactivity available. Fuel consumption can then be compensated for by adding small amounts of deuterium oxide, and the excess reactivity present need never exceed the desired low value of 0.75% k.

The AGN 211 reactor is even more flexible. Aside from certain disadvantages inherent in swimming pool-type reactors, this reactor has unrivaled accessibility and adaptability in its class. It is purportedly the only reactor in which the core materials and critical geometry can be varied in three dimensions without fabricating new fuel elements for each variation.

Changes in negative reactivity are made by changing the concentration of neutron absorbers or poisons in the core region. Such changes are typically accomplished in the AGN 211 reactor by two Boral safety rods: an aluminum-clad cadmium rod for coarse control and a stainless steel rod for fine control.

In a subcritical heterogeneous reactor using natural uranium and light water moderator (such as NC 9000), no control system is needed to prevent it from going critical accidentally. Natural uranium can go critical only when it is used in combination with heavy water.

3. Moderator materials

Neutrons released during fission have very large kinetic energies—as high as 2 mev (million electron volts). Moderation changes this kinetic energy to thermal energy by forcing the neutrons to collide with the nuclides of construction materials. The best moderator materials have low atomic weight, high scattering cross section, large energy loss per collision, and low absorption cross section for thermal neutrons.

Water, beryllium and graphite have good properties

In this discussion we can ignore aqueous homogeneous reactors since their moderator-fuel makeup is largely fixed. Although relatively expensive, heavy water, beryllium and graphite are eminently suited as moderator materials and provide lower fuel loadings than other materials such as light water. However, extra fuel loading in a light water reactor is advantageous since it enables the U-235 fuel to compete more favorably with water for neutrons in the fuel region. Thus, thermal utilization may be almost the same whether heavy water or light water is used.

However, apart from the above, the designer must transport, with minimum losses, the maximum number of excess neutron to where they can be experimentally used. Low absorption materials provide

an efficient "piping system." Deuterium dioxide in particular delivers more neutrons per gram of uranium consumed than any other —its efficiency of delivery is almost 100%.

Organic materials are inexpensive

Less expensive moderator materials are also available with properties approaching those of heavy water, beryllium and graphite. In addition to light water, organic materials such as the polyphenyls, paraffin and polyethylene can be used. These organics are particularly interesting because of their:

1. High hydrogen-to-carbon atom ratio.
2. Compatibility with fuel, can and other structural materials, resulting in low corrosion rates.
3. Low induced radioactivity.
4. Elimination of hazardous chemical reactions.
5. Fair resistance to radiation damage (see table on p 113).

Organic moderator materials help to reduce cost since they can be used with inexpensive carbon and low alloy structural steels. They also permit weight reductions because of their compatibility with light, low-cross-section materials like aluminum.

Organics plus metals offer good combination

The fair resistance of the organics to radiation damage can be improved by mixing them with appropriate reflector, gamma shield or fuel materials. The composites perform dual roles, improving both the durability of the organic material and the effectiveness of the metal. Combination with lead or lead-lithium pellets, for example, reduces energy absorption by the organic material. This technique is used in the multi-region primary of the L-77 reactor.

The relatively poor heat transfer properties of the organics can also be offset by combining them with other materials. For example, intimately mixing hydrogenous organics with lead or other metals increases thermal conductivity and specific heat, thus allowing higher operating temperatures, eliminating hot spots, etc.

The AGN 211 reactor uses fuel elements made of 20% enriched uranium dioxide particles embedded in a radiation-stabilized polyethylene. This system has an inherent safety advantage due to the negligible time delay in the transfer of heat from the fuel particles to the polyethylene moderator. If something should go wrong the prompt heating of the moderator would increase the thermal energy of the neutrons and tend to reduce fission-to-capture probability. Furthermore, the prompt heat expansion in the fuel-moderator elements causes a decrease in density and increases leakage from the core, resulting in immediate shutdown.

4. Reflector materials

The purpose of a reflector is to return to the core leakage neutrons that are not intended for experimental use. The size of the core (fuel and moderator), its critical mass, and its cost are substantially affected by the presence of a reflector.

Important selection factors

Like the best moderators, reflector materials are characterized by a high scattering cross section and low neutron absorption. They should be chosen so as to:

1. Minimize costs.
2. Provide a large negative temperature and void coefficient (these quantities tend to increase with a decrease in reflector thickness).
3. Eliminate or reduce core-reflector interface flux peaking and smooth flux distribution in the core.
4. Properly control the flow of neutrons into experiments.

Lead reduces weight, cost

One of the most useful reflector materials for portable research and training reactors is lead. Important savings in weight and costs are obtained when it is used in the dual role of reflector and gamma shield. The homogeneous L-47 reactor (now replaced by the more refined L-77) was the first to use lead in this way.

Lead acts as an essentially infinite reflector in the L-47 design. This means that experimental apparatus used at or near the reflector surface will not perturb the neutron balance in the core. Furthermore, no hazard is presented in the vicinity of the reflector when the apparatus is moved during operation.

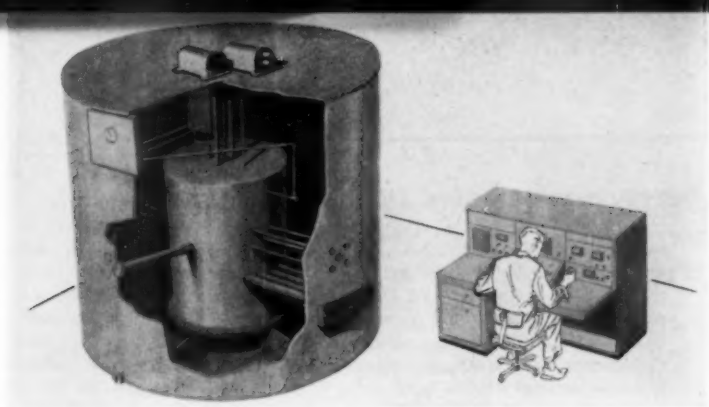
Also, since lead acts as an effective shield against in-core residual gammas, personnel have access to the interior when the secondary shield water tank is drained. In addition, since the lead is cast and bonded around the core vessel it helps improve the resistance of the core vessel to any sudden pressure surges that may occur.

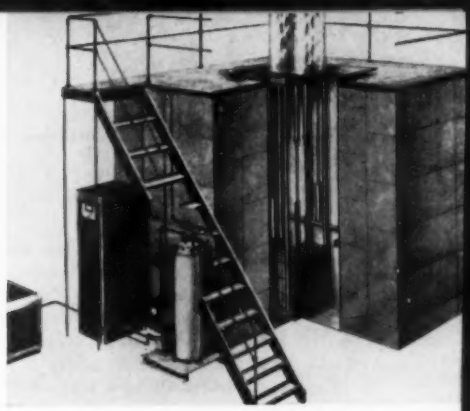
The L-77 carried the use of multipurpose materials even further. Here an intimate mixture of lead shot and diphenyl is used inside the primary structure to provide neutron shielding or moderation in combination with gamma shielding or reflection.

Composition hardboard also low in cost

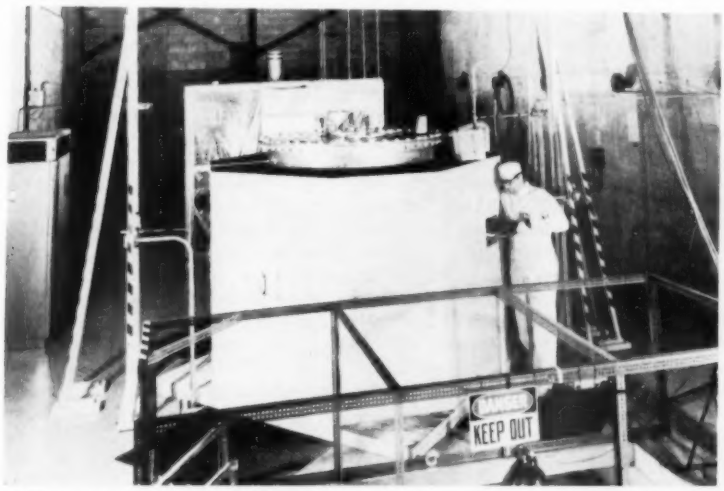
Another popular reflector material is composition hardboard. Hardboard has good nuclear properties and maintains high neutron flux density within the core and experimental region. It is relatively free of impurities that absorb neutrons and has a large scattering cross section. Furthermore, it is inexpensive, readily available, and offers good resistance to moisture and heat.

In designing the TRR reactor several reflector materials were considered, such as graphite, heavy and light water, beryllium and wood planking. Because of its low cost and other desirable properties hardboard was chosen

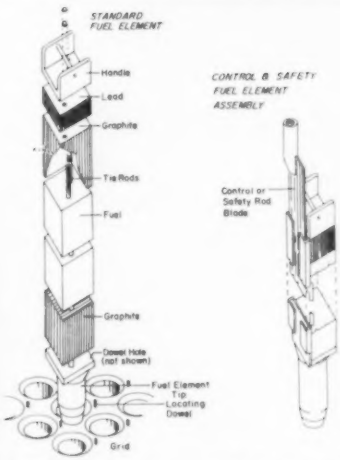




L-77 reactor *uses fuel of uranyl sulfate enriched to 20% or more in U-235. Moderator is light water; reflector is lead pellets in diphenyl material.*



TRR reactor *with shielding removed. Neutron reflector used on sides and bottom consists of 1 ft of graphite sheathed with 3 in. of masonite which in turn is covered with ½-in. layer of borated (8 to 10%) polyethylene shielding. Additional shield (not shown) consists of 6-ft layer of ordinary concrete blocks. Enriched uranium fuel is centrally located in aluminum reactor tank and is cooled by natural convection of heavy water.*



AGN 211 *reactor and fuel element assembly. Moderator is made of polyethylene, reflector of 3 to 5-in. thick graphite, and shielding of concrete. The center 10 in. of each fuel element is composed of a homogeneous mixture of uranium dioxide in polyethylene. A 5-in. graphite reflector is used at each end of fuel element and a 2-in. lead shadow shield is used at outer ends of graphite.*

to supplement graphite and heavy water reflectors. Cost of the hardboard for this application was $1.10 (all prices per sq ft) as compared to $38 for graphite, $600 for heavy water and $3000 for beryllium. Wood planking was rejected because it was less homogeneous than hardboard and more susceptible to warping and shrinking. Light water was rejected since it required a container that would be difficult to erect and modify. The hardboard is used in a 4-in. thick laminate made up of 5 layers, weighs 3.1 lb per sq ft, and is structurally self-supporting.

5. Shielding materials

Shielding falls into two broad classifications: thermal and biological. Thermal shielding is used to dissipate excessive heat from high absorption of radiation energy. It is not needed with small portable reactors because of their low power levels. Biological shielding, however, is needed to reduce gamma and neutron radiation at the outside surface of the reactor to a tolerable level—generally agreed to be 7.5 millirems per hr.

Unfortunately, materials that effectively stop neutrons are poor gamma absorbers. Up to about 3 mev, neutrons are attenuated best by low-atomic-weight materials. Conversely, good gamma absorbers should have high atomic weight.

In addition to having proper nuclear properties, shielding materials must be inexpensive and readily available since they are used in large quantities. Typical good shielding materials are lead, polyethylene, iron, concrete and water. Numerous metals may be used for shielding but lead is preferred because it can be used rela-

Three Important Design Objectives

1. Minimize radiation damage

Although the flux level in portable research and training reactors is usually lower than in other reactors, radiation can still affect the structural integrity of materials and components.

Radiation resistance depends on many variables and cannot be predicted with absolute assurance (see "Radiation Damage in Metals," M/DE, Jan '60, p 89). Complete assemblies may aid constituent parts or materials. On the other hand, the proximity of certain materials may render useless otherwise resistant materials. Some materials may have a lower threshold value than others, but may be more resistant to higher dosages. For example, nylon shows radiation damage sooner than TFE fluorocarbon, but with increasing dosage nylon maintains fair integrity long after TFE fluorocarbon has failed. Similarly, devices such as semiconductor diodes and triodes continue to function with degraded performance at dosages far above the damage threshold. In short, extrapolated damage data should be checked by actual tests.

The tables at far right show the approximate levels at which damage occurs for various reactor materials and components exposed to irradiation. These levels are conservative, and in most cases the specimens also received an equal number of gamma photons. From the data and considering power levels it is apparent that organic materials and some electrical components are most likely to be affected by irradiation. Selection of the most resistant material should be consistent with nuclear and cost requirements. Most instrumentation prone to damage can be relegated to remote consoles and positions. However, this may be impossible with electrical machinery, drive mechanisms, etc.

Electrical failures can be caused by insulation or lubrication breakdown. Formex and polyvinyl formal insulations for magnet wire appear to be quite resistant at medium temperatures. Nylon, polystyrene, polybutyral, mineral-filled phenol formaldehyde, polyester and furane plastics are all good organic insulations capable of withstanding high radiation dosage, although their physical changes must be considered in specific applications. Acrylic, TFE and CFE fluorocarbons, vinylidene chloride copolymers, casein, vinyl, epoxy and all cellulosic materials become poor insulations when exposed to high dosage. Alnico permanent magnets are not appreciably affected. Increasing radiation resistance is exhibited by the inorganic, inorganic-filled and heat resistant insulation materials. The best known insulations under intense radiation are glass and quartz which deteriorate very slowly.

No physical damage is observed in temperature sensitive devices such as thermocouples and resistance thermometers below dosages at which the basic materials are affected. The damage in these components is primarily caused by temperature rise due to irradiation. Radiation heating is a characteristic problem in energetic-type reactors and requires the use of pressure shells and special heat dissipation shields. It is not normally encountered in low-power "package" reactors.

2. Minimize corrosion

Salts containing boron are frequently used in water shields to further attenuate neutrons and to reduce radiolysis. Tests show the following range of corrosion rates (in mils per year) of metals in several borated solutions: lead, 0.1 to 0.6; mild steel, 0 to 0.3; mild steel-lead combinations, 0.3 to 0.9. These rates are negligible. Stainless steel can be expected to have still lower rates. Aluminum, however, despite its good corrosion resistance, is susceptible to galvanic attack.

An example of how corrosion can occur in portable reactors is provided by the NC 9000 reactor. Corrosion was traced to galvanic action between core components and the tank material. It was found that galvanic action could be stopped by replacing tap water with purified water having higher electroylytic resistance.

Corrosion can also be prevented by using suitable inhibitors in solution. Tests conducted with a 1630 ppm lithium chromate solution show that its inhibiting action is effective for at least six months with carbon steel, copper and lead.

tively thin, thus providing cost and weight savings.

Designing primary and secondary shielding

The primary or first shielding immediately surrounds the core or core structure. It is made of solid materials, is invariably leakproof, and in such reactors as AGN 201 and L-77 is made integral with the package. Great attention is required in its design since it comprises much of the overall cost and weight.

By nature of their design, swimming pool reactors such as AGN 211 do not have a leakproof primary shielding. However, the induced core radiation level of this reactor is low enough for safe fuel handling while providing sufficient flux for many activation experiments.

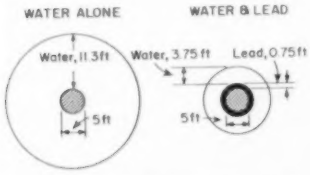
Secondary shielding is not considered part of the reactor package since it is usually erected on the site. Water and/or concrete blocks are frequently used as secondary shielding. Unlike primary shielding, secondary shielding is not used in equal thickness around the entire reactor. Secondary shielding requirements above or below the reactor can be minimized by taking into account the benefits of the foundation or floor below the reactor and uninhabited air space above the reactor.

In most designs access to the

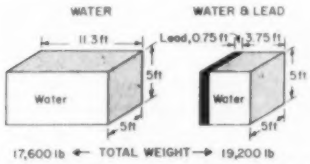
3. Minimize weight

Naturally the weight of portable reactors has to be kept to a minimum. However, compromises in materials selection are inevitable, and the usual practice is to use mixtures or layers of gamma and neutron absorbers.

Simple geometry tells us that considerable weight savings are obtainable with circular polyshields. The first drawing below shows the approximate weight difference in two shields designed to provide the same dose constraint. As indicated, the lead-water design has a considerable weight advantage over the all-water design. Similar comparisons for slab-type shields are shown in the second drawing.



***Comparative weights** of spherical shields made of water alone and double layer of water and lead.* (Hemmid)



***Comparative weights** of slab shields made of water and water plus lead.* (Hemmid)

SUMMARY OF DAMAGE THRESHOLDS FOR REACTOR MATERIALS AND COMPONENTS

Material or Component	Radiation Level, nvt[a]
Ductile and Fluid Metals (control poisons, shields, reflectors)	3×10^{22}
Many Simple Inorganic Compounds	3×10^{20}
Plastics (moderators, shields, reflectors)[b]	1×10^{15}–1×10^{19}
Bearings in Special Lubricants	6×10^{17}
Permanent Magnets	3×10^{17}
Capacitors and Small Motors[b]	1×10^{17}
Resistors, Small Transformers, Electron Tubes[b]	3×10^{16}
Dry rectifiers	1×10^{16}
Organic Fluids (oils, greases, shields, moderators)[b]	1×10^{16}
Silicon Diodes	1×10^{13}
Transistors	1×10^{12}

[a] In most cases samples also received an equal number of gamma photons.
[b] See also tables below.

RADIATION DAMAGE TO REACTOR AND SHIELD COMPONENTS[a]

Material ↓	Type of Damage	Estimated Threshold Damage (25%), rads
Water	Gas evolution, corrosion	Infinite
Paraffin and Olefin Hydrocarbons	Gas evolution, polymerization	1×10^{8}
Monopheynl Hydrocarbons	Same as above	3×10^{8}
Diphenyl and Polyphenyl Hydrocarbons	Same as above	1.4×10^{9}

[a] From V. P. Calkins, "Radiation Damage to Nonmetallic Materials," (unclassified AEC report).
[b] 1×10^{8} rads corresponds approximately to combined radiation of 3×10^{17} thermal neutrons/sq cm, 3×10^{16} fast neutrons/sq cm (above 0.7 mev), and 1.5×10^{17} gammas/sq cm (average energy = 1 mev).

RADIATION DAMAGE TO CONTROLS AND INSTRUMENT COMPONENTS

Component ↓	Radiation-Susceptible Material	Estimated Threshold Damage (25%), rads
Capacitor	Paper or oil dielectric, phenolic or wax paper cover	4.5–7×10^{6}
Resistor	Plastic cover	4.5–7×10^{6}
Microswitch	Plastic case and actuator	4.5–7×10^{6}
Selsyn	Organic wire insulation, brush holder, slot liners, and punchings and casing insulation.	4.5–7×10^{8}

reactor is lateral or radial and it is in these directions that shielding requirements and dimensions are greatest. Thus, reactors are generally somewhat wider than they are high. However, overall diameter is usually kept under 8 ft to facilitate transport. When water or some other liquid is used for secondary shielding the tank can double as a structural support for the core and/or the primary shielding.

The AGN 211 and NC 9000 reactors differ from others in that experimental access to the core is from the top of the reactor. Shielding for the AGN 211 in the radial directions is provided by 40 in. of concrete in the form of overlapping blocks. Vertical shielding is provided by 6 in. of graphite, 2 in. of lead and 4½ feet of water.

Attenuating neutrons

Neutrons are absorbed in two stages. First, high energy neutrons passing through a shield are slowed by elastic or inelastic scattering; the capture cross section for neutrons at high energies is extremely small. The second stage of capture occurs only when the energy of neutrons drops to low values. Large cross sections of most elements will produce quick capture of low energy or slowed neutrons. Therefore, the usefulness of neutron shield ma-

terials depends largely on their ability to attenuate high energy neutrons.

Elastic and inelastic scattering are produced by collisions between high energy neutrons and the shield nuclei. In inelastic scattering the recoil nucleus is left in an excited state and it therefore absorbs a larger fraction of energy than it does with elastic scattering. In general, inelastic scattering is more important with heavier nuclei which can be more easily raised to excited states. Elastic scattering is more important with light nuclei which can absorb a large amount of energy via recoil.

Neutron shielding must also be designed to protect against secondary gamma radiation produced by inelastic scattering and capture. This can be done by incorporating absorbers such as boron which reduce the energy of capture gammas and remove low energy neutrons as they are produced. Boron can be used in the form of soluble or insoluble salts, depending on the medium, or in the form of Boral, a mixture of aluminum and boron carbide. The TRR reactor uses a borated plastic; the L-77 reactor uses borated paraffin.

Attenuating gamma radiation

The effectiveness of a material in shielding against gamma radiation depends strongly on its specific gravity or atomic number, i.e., electron density. It is useful to remember that a gamma intensity of 2 mev is reduced by a factor of ten by 19 in. of water, 10 in. of concrete, 2.6 in. of iron and 1.7 in. of lead.

Gamma shields in themselves are also a source of neutron-produced gamma radiation or secondary radiation resulting from capture. This adds to the secondary emission of hydrogenous shields and to the attendant weight of shielding required. According to *Jansen et al*, a lead-lithium alloy shows good potential protection. Because of its thermal neutron absorption properties, lithium is effective in suppressing gamma ray production resulting from neutron interaction with lead. The alpha radiation produced has an extremely short range—several microns in lead—and is comparatively harmless. Although the alloy tends to corrode in air and water, corrosion can be prevented by incorporating it in hydrocarbon materials. Lead is virtually inert to nonpolar hydrocarbons and only slightly attacked by most polar materials.

Use of a lead-boron alloy for gamma shielding has not proved feasible because boron is only slightly soluble in lead. Similarly, production of the alloy by powder metallurgy has not worked out because of segregation problems. However, a cementation technique developed by Battelle Memorial Institute appears promising (see *Williams et al*).

Composite shielding combines advantages of single materials

Organic-lead mixtures are advantageous where it is desirable to have a hydrogenous material for neutron attenuation together with a heavy material with a high neutron inelastic cross section but low gamma ray production efficiency as the gamma attenuator. Since carbon is a good source of hard gammas when bombarded by high energy neutrons, it is desirable to distribute lead throughout carbon shields. In addition to satisfying nuclear requirements, mixtures of lead pellets and organic materials provide good design flexibility and inherent safety. Also, homogeneous mixtures are easily cast into shapes and easier to work with than laminated layers.

Spherical lead pellets have been used to advantage in the unique primary shield of the L-77 reactor. This shield consists of three concentric regions. The innermost region is composed of a mixture of lead pellets and diphenyl which surrounds a stainless steel sphere containing uranyl sulfate. It acts primarily to reduce neutron leakage, moderate escaping neutrons, and attenuate gamma radiation. The central shield region is composed of borated paraffin which further moderates radiation and captures a significant portion of thermalized neutrons. The third region, made of a mixture of lead pellets and paraffin, acts as a neutron-gamma shield.

Mixtures of lead and paraffin should be made as light as possible. Since neutrons create hard gammas in the carbon of the paraffin, there is no need to have more lead than is necessary to reduce the core gamma strength to approximately the same level as the neutron-induced secondary gamma strength. (Boron additions can serve to reduce the secondary gamma level. Lithium on the other hand could reduce the contribution of lead and the hydrocarbons.) This may suggest use of lead powder suspensions; however, these could tend to separate by gravity over prolonged periods at moderate temperatures. This would not be the case with pellet shields.

According to *Race*, cylindrical pellets would be less expensive than most spherical pellets. Also, the effective density of composite shielding can be varied without affecting the packing factor by using a cylinder of one material (e.g., carbon steel) with a liquid core or core of another metal (e.g., lead). This arrangement permits uniform materials distribution—more so than a random mixture of solid pellets of different materials. Also, by using cylindrical pellets to realize a specific packing factor, it is possible to obtain a range of gamma and neutron stopping ratios by changing pellet core size and the filling material. The average packing factor for a random arrangement of single-size cylinders (with length equal to diameter) is 0.366—slightly less than that of random-packed, single-size spheres which have a packing factor of 0.4.

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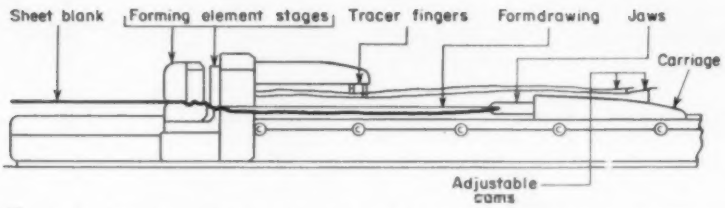
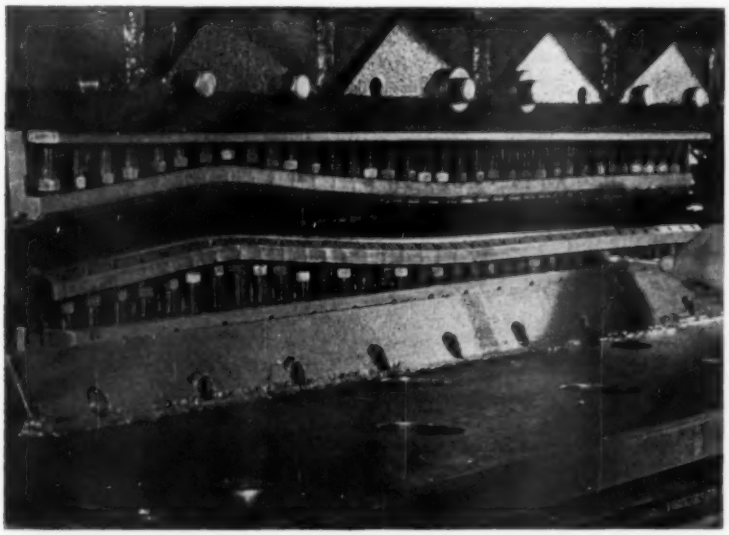


1 ***Androform machine*** *as shown by schematic drawing through centerline.*



2 ***Closeup view*** *of adjustable forming element.*

Bending Plus Stretching Cuts Cost of Contoured Sheet Parts by ...

- *Eliminating dies and thus cutting lead time*
- *Forming difficult metals*
- *Eliminating intermediate treatments*
- *Reducing scrap*

by Donald Peckner, *Associate Editor, Materials in Design Engineering*

■ A sheet metal forming process developed by Anderson Aircraft Corp. eliminates the need for the large number of dies required in conventional stretch forming operations. Although developed primarily for the aircraft industry, the process should find applications outside this field. Other products that might be manufactured by the Androform process include: automotive body panels, truck structural panels, boat hulls and architectural panels. A typical current application is forming segments for a 60-ft dia radar reflector.

How the process works

The Androform process is basically a differential stretch forming technique. Sheets are contoured by varying the shape of a standard set of forming elements. The machine (see Fig 1) is composed of three basic forming element stages. Stage 1 plastically bends the blank in the longitudinal direction (radius of curvature lengthwise to the sheet); stage 2 plastically stretches the blank in a transverse direction. Stage 3, essentially, acts as a wiper on stage 2 to prevent or control compression buckling of the sheet. Fig 2 is a close-up view of the stage 3 element.

Manipulation of these three forming elements is automatically controlled hydraulically by the use of tracer fingers (or followers) that are actuated by several adjustable, segmented templates. As the gripper head pulls the sheet between the forming elements the followers trace over templates and regulate: a) gap (and, therefore, tensile force applied by stage 1); b) gap and bending moment applied by stages 2 and 3; c) relative vertical positions of stages 2 and 3 with respect to stage 1; d) relative horizontal spacing between stages 2 and 3 and stage 1.

Controlling the relative positions of the forming elements in stage 1 with respect to each other results in an initial tensile force on the sheet at or near the yield strength of the material. Additional loads are required in stages 1, 2 and 3 to produce simultaneous bending in both the longitudinal and transverse directions. Applying bending stresses at right angles to each other and superimposing a tensile stress establishes a multiaxial stress distribution which allows flow to occur at a maximum stress lower than that required to produce flow by tension alone (as in stretch forming).

By controlling the relative spacing between forming elements, the neutral axis during bending

(in either plane) can be adjusted to be in the center of the sheet (pure bending), outside the sheet on the concave side (pure stretching) or any location between (for combined bending and stretching).

What are the advantages?

Androforming has several important advantages over standard stretch forming procedures. Since no forming dies have to be made, lead time is almost completely eliminated. Scrap losses are reduced as much as 95%. Other advantages are: alloys with poor formability characteristics are readily formed at ambient temperatures; formed parts have smoother surfaces; and many intermediate steps such as annealing, heat treating and prior preparation are eliminated.

Materials that can be formed

To date, the following metals have been formed:

Aluminum alloys: 2024T3, 2024-T81, 7075T6, 7178T6.

Stainless steels: 301 (full hard); 302 (full hard); 17-7 PH: AM350 (½ hard); AMS5532.

Titanium alloys: AMS 4900; AMS 4901; AMS 4908; RS110AT: 6A1-4V.

Magnesium alloy: AZ31A.

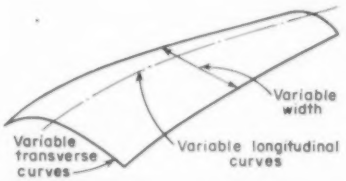
Shapes, sizes, reproducibility

Fig 3 is a sketch showing how the surface of an Androformed panel may be varied. Thickness of the formed parts is uniform and the formed panels are identical. Fig 4 shows stacked skins which illustrate the uniformity of the process. Shapes can be widely varied as follows: simple contour, compound contour, convex-concave contour or combinations of these three forms. The centerline of the contour can be made parallel to the panel sides, at an angle to the panel sides, or on an arc or curve.

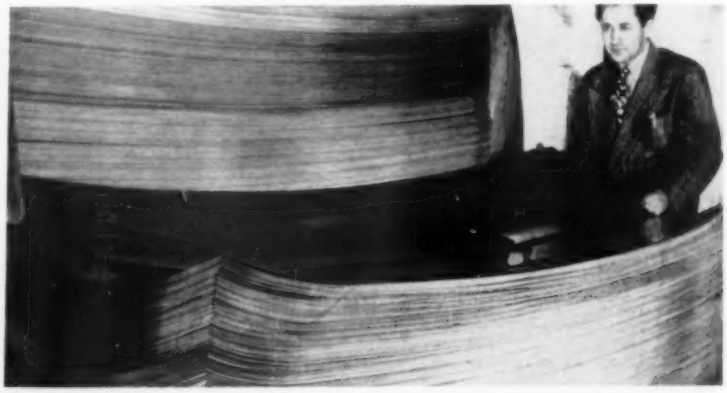
Maximum contour that can be formed is dependent on variables such as difference in length and gage of the starting sheet and the yield point of the material.

Androforming allows the designer to consider the possibility of forming parts in one continuous sheet rather than as a series of welded or riveted components. Machine capacities range in metal thickness from 1/8 to 9/16 in., widths up to 120 in. and lengths as long as 48 ft.

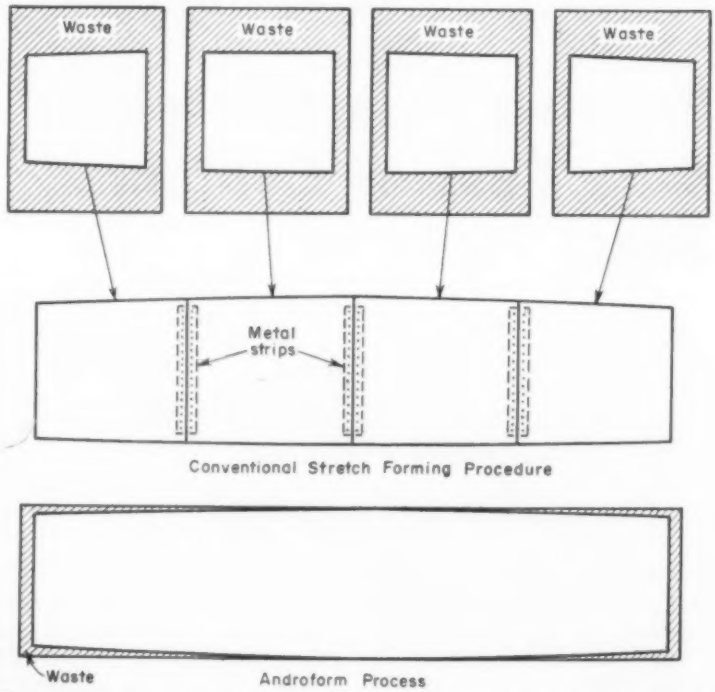
Fig 5 shows the difference between standard stretch forming procedure on a bomb bay door and the Androform process. As a result of Androforming the door, up to 50 percent of the metal normally required is saved, the door is subjected to a minimum of cold working, residual stresses are distributed uniformly throughout the part, weight of the part is reduced by elimination of rivets and reinforcing strips at the joints, and tool costs are practically eliminated.



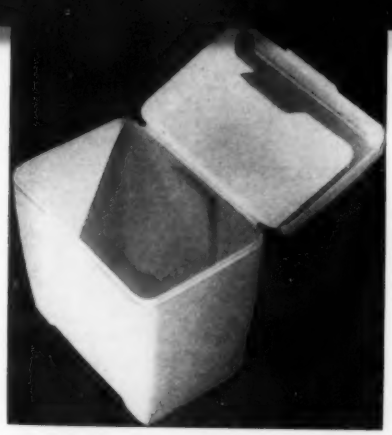
3 ***Variable compound curvatures*** *with constant thickness can be obtained with Androform process.*



4 ***Stacked panels*** *made by process show that parts are uniform..*



5 ***Bomb bay door*** *made in one Androform operation eliminates four panels and need for joining.*



Record case—*Simple integral hinge provides low cost efficiency in the Platter Porter record case produced by Columbus Plastics Products, Inc.*

Glasses case—*Integral hinge makes economical, attractive case for safety glasses. According to producer, Parmelee Plastics Co., cases were opened and closed 1000 times (equivalent to a year's normal service) with no appreciable weakening of hinge area.*

These original designs show potential of . . .

The Polypropylene Hinge: Long Life at Low Cost

How it works . . . how to design one . . . and some outstanding examples of successful use

by Malcolm W. Riley,
Associate Editor, Materials in Design Engineering

■ Substantial cost and performance benefits are being realized through the use of a unique "hinge characteristic" of polypropylene. Flexible plastics such as vinyls and low density polyethylenes have been used previously for flexible hinge-type components. But in polypropylene you have a rigid yet resilient material which, in thin sections, provides virtually unlimited flex life. Consequently, relatively rigid components such as containers can be molded with integral hinges.

All the applications discussed in this article use Pro-Fax, the polypropylene produced by Hercules Powder Co.

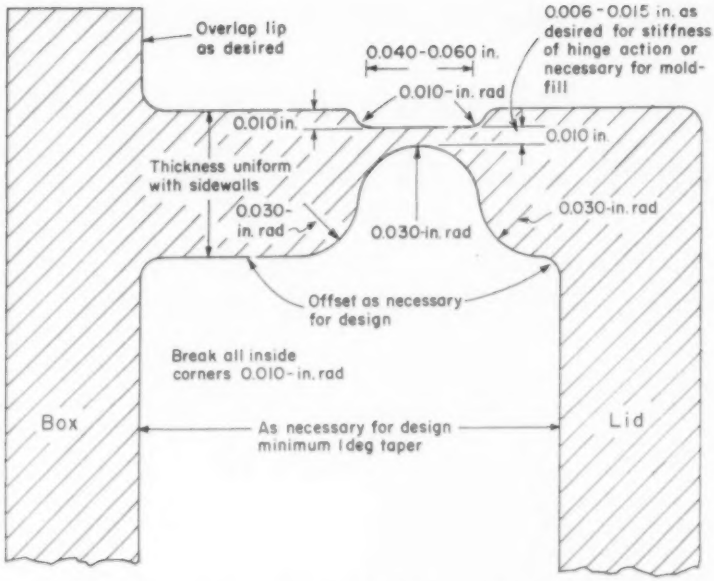
Why and how the hinge works

Why the material behaves the way it does is not fully understood. It undoubtedly involves such characteristics of polypropylene as 1) its crystalline nature which permits substantial increases in strength through orientation or stretching, 2) its high elongation beyond the yield point, 3) its complete resistance to stress cracking, and 4) the fact that it forms a tough skin during molding or extruding.

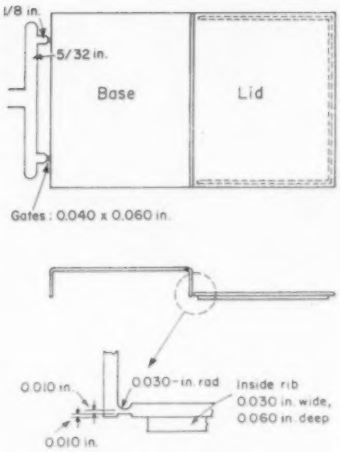
Here is the explanation given by R. D. Hanna of Hercules Powder Co.: As molded, a polypropylene hinge web has unit tensile strength and stiffness equivalent to that of any other section of the molding. It therefore has some resistance to flexing. However, on the first flex of this relatively confined area, fiber stress in the

Photos this page courtesy Hercules Powder Co.

Tubing clamp—*Low cost, disposable clamp for tubing required excellent environmental stress cracking resistance, and is intended for use at most about a dozen times. Developed by Pacific Plastic Products, this polypropylene clamp has been cycled 250,000 times without hinge failure.*



1—Design recommendations for a standard polypropylene hinge. (Hercules Powder Co.)



2—Layout for mold design indicating optimum arrangement for flow of material. (Hercules Powder Co.)

outer surface causes elongation exceeding the yield point, thus orienting the crystallite structure and causing necking down in that area. Such orientation increases tensile strength. Further flexing will increase orientation and the hinge will actually become stronger with use. (For further information on effects of orientation see "Oriented Thermoplastic Sheet and Film," M/DE, Dec '59, p 94.)

Other thermoplastics, such as high density polyethylene, have several of polypropylene's characteristics. But none appears to provide the balance of properties required to give hinge performance comparable to that of polypropylene. For example, one laboratory reports flexing a polypropylene hinge 300,000 times over a 180-deg angle at both 75 and –20 F with no indication of failure. Others report discontinuing tests after 1 million flexes with no evidence of failure.

Hinge design: simplicity itself

Design is simple. A sketch of Hercules Powder's standard hinge design is shown in Fig 1. Essentially the polypropylene hinge is a molded or cold formed web similar to a flash gate. Land length (or hinge width) should be 0.040-0.060 in. or greater, depending on the function of the hinge. Web thickness should be 0.006-0.015 in., depending on either the stiffness desired in the hinge action, or the requirements for filling the mold. Ideally, flow of material should be from the base or heavier section through the hinge area and into the lid or lighter section, as shown in Fig 2. In any case, for best performance flow should be through the hinge and perpendicular to the hinge line.

All corners in the area of the hinge should be radiused to improve both flow of the material and physical properties of the part. Typical radii are shown in Fig 1.

To increase rigidity and improve the fit of hinged mating parts, a lip or other interlocking feature should be incorporated in the design.

In cases where molding in the hinge may be costly or difficult, successful hinges can be cold formed. The thin hinge web can be postformed by such a device as an arbor press which can force the material to cold flow under moderate pressure.

Three case histories

Auto air conditioner registers—lower cost, lighter weight, more efficiency

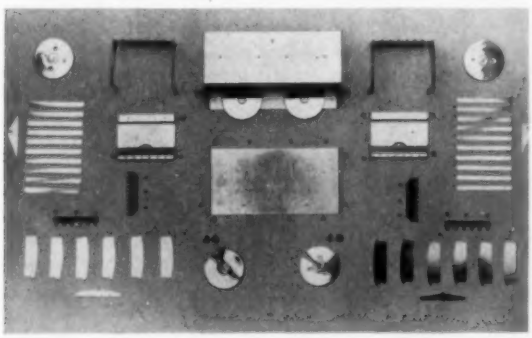
Air deflection registers for car air conditioners have been redesigned by Eaton Mfg. Co.'s Heater Div., to make use of the polypropylene hinge. According to R. D. Emery, project engineer, the redesign resulted in 66% reduction in cost, 68% reduction in assembly time, 92.5% reduction in weight of the unit, and elimination of rattles and squeaks as well as lubrication.

The accompanying pictures show exploded views of the design in metal and the design in polypropylene, as well as the registers installed in a car. In the exploded view of the new design, the two large parts in the center show the molded deflectors with integral molded-in hinges. Each of the blades is connected to a rigid base bar by a thin membrane which serves as the hinge. All the

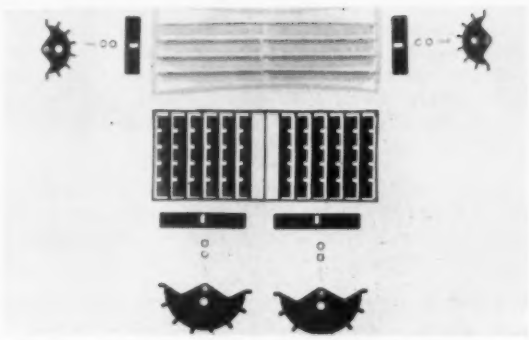
AUTO AIR CONDITIONER REGISTERS

Photos courtesy Eaton Mfg. Co.

Complete assembly *with polypropylene hinged deflectors installed in car.*



Before . . . *Exploded view of parts required for old metal register assembly*



After . . . *Exploded view of parts required for new polypropylene register assembly. Deflectors on moldings in center are integrally hinged to base bars.*

base bars are molded to a common frame.

According to Emery, several sets of louvers were life-tested by deflecting them through an included angle of 120 deg at a rate of 360 deflections per hour. All the blades withstood 300,000 deflections at temperatures ranging from 0 to 200 F. No weakening of the hinge section was found.

Other benefits included excellent, glossy surface finish with a good "feel," good dimensional stability, and high resistance to grease, oil and ultraviolet light.

Original tooling costs were somewhat higher for the injection molding dies than for the blanking and coining dies required for metal fabrication.

Auto accelerator pedal—lower cost, improved operation

On the threshold of commercial use are polypropylene accelerator pedals with integrally molded hinges. A rough prototype of the pedals, developed by Millington Mfg. Corp., is shown at the right in the photos on the next page comparing the various types of pedal constructions in common use. Although data are unavailable as yet from specific auto manufacturers, all the major producers are reported to have such pedals under evaluation.

Although present pedal designs vary, as shown in the photos, most pedals combine metal and rubber: In some, metal is used in the hinge, as well as providing structural support; in others, metal provides only rigidity and the rubber serves as the hinge.

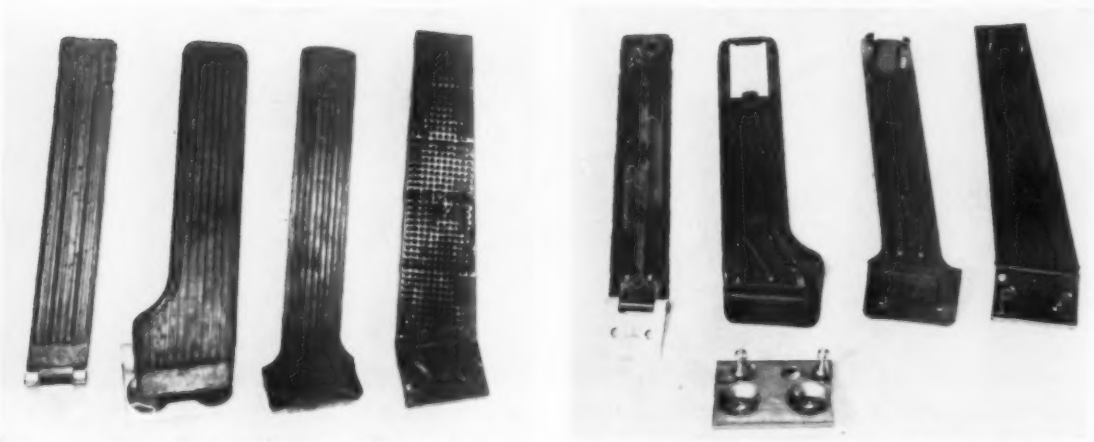
Compared with such constructions, polypropylene pedals are reported to provide a reduction of from 50 to 70% in initial cost, lighter weight, and further economies in accessory parts and assembly time. The molded pedals can be altered to permit installation with any conventionally used attachment system.

Polypropylene pedals are reported to have been tested by flexing ½ million times with no load, then ½ million times under loading experienced when the pedal is "floorboarded," at both subzero and elevated temperatures. No bad effects were noted.

ACCELERATOR PEDALS

TOP VIEW

BOTTOM VIEW



Prototype polypropylene *accelerator pedal, developed by Millington Mfg. Co. is shown at right of both photos which compare it with conventional pedals. Other pedals are (left to right): Studebaker rubber-covered metal pedal with all-metal hinge; Chevrolet rubber-covered metal pedal, attached by spherical bosses on metal floorplate; Ford rubber-covered metal pedal with rubber hinge. Top view shows different attachment methods. Polypropylene pedal can be adapted to fit any of the conventional designs.*

Additional advantages over rubber surfaced pedals include better wear and abrasion resistance, and excellent resistance to road surfacing compositions and other chemicals and greases.

Many styling possibilities exist. Polypropylene can be colored to match interior trim, or symbols and nameplates in contrasting colors can be molded-in or subsequently applied.

Air conditioner retainer strip—simplified assembly, efficient operation

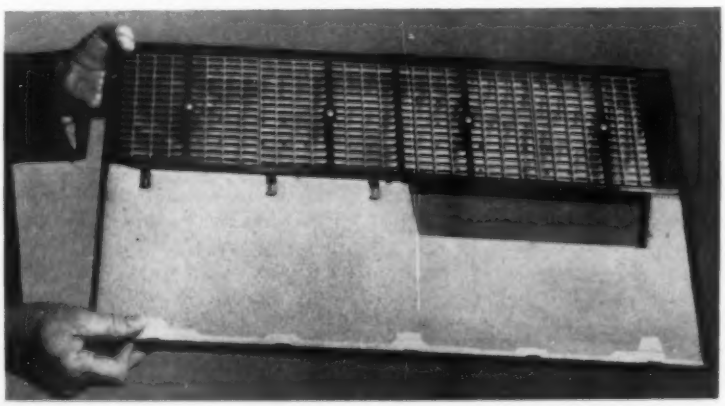
In the redesign of the 1960 Westinghouse room air conditioner, the hinging characteristic of polypropylene was put to use in the filter retainer strip shown in the accompanying photo. The strip has three integrally molded hinged clips that snap-lock in place when the filter is installed. The hinge membranes are 0.006-0.008 in. thick and 0.020 in. wide.

Since this was an overall redesign of the front of the air conditioner, no direct comparisons are possible. However, Westinghouse reports that the polypropylene strip replaces an adhesive bonded plastics assembly with S-shaped wire snaps which held the filter in place.

According to F. S. Metcalfe, of Westinghouse's Product Engineering Dept., polypropylene was selected for this strip primarily because of its hinging characteristics, as well as its rigidity which permitted the snap fit. Metcalfe also says polypropylene's molding qualities were found to be reliable and no problem was encountered in warpage and distortion.

Flex fatigue in the hinge was not considered a problem. In the normal life of the unit, the filter would probably not be changed more than 100 times. Westinghouse flexed the hinges about 2000 times with no indication of failure. At time of writing 100,000 such units are reported to have been sold with no reports of failures in this part.

AIR CONDITIONER RETAINER STRIP



Retainer strip *for Westinghouse Room Air Conditioner has three integrally molded hinged clips which hold air filter.*

Your Specifications

Can Make You or Break You

Here are some pitfalls you should avoid.

by Alfred K. Thornton, *Chemical and Materials Evaluation Dept., United States Testing Co., Inc.*

Keep your requirements in balance

Meaningful specifications represent a delicate balance between economy and satisfaction of all end-use requirements. And they call for the best minds in a company, seasoned judgment and sound evaluation.

Every successful product must satisfy three important requirements, all of which are limited by cost:

1. Is it safe to use?
2. Will it do the job?
3. Will it stand up during its required life?

We see all of these requirements in *balance* with products that are operating successfully and are being made at a profit. We see an *unbalance* when there are accidents, poor performance and breakdowns—in short poor reliability. Then, one or more of the requirements has been violated.

The most important objective in producing any product is to get the right balance of requirements. Too much emphasis on any one requirement is often as bad as too little. The designer who over-specifies to play it safe or because of a mistaken idea of quality can hurt his company's competitive position. Contrarily, the designer who under-specifies through false economy can damage his company's reputation. And last, the designer who does not use any specifications at all and relies on an informal system of quality control is leaving his company wide open for trouble.

In short, remember the parable of the one horse shay. It was *very safe* for many years and it *did its job* exceptionally well. As far as *durability* was concerned, it was designed so that no one part was better than any other. They all gave out at once! The maker had a good spec.

Overdesign: safe but costly

It is a natural and laudable tendency of many designers to specify maximum mechanical and physical properties in their products. However, this practice can lead to high costs.

Take the case of the designer who drew up a driveshaft for a new pump his company was introducing. Using his handbook as a guide, he selected a high strength steel and then specified a depth of case hardening well in excess of any possible demand. Though the designer met the requirements of utility and safety, the cost of his product was out of bounds. Fortunately, when the design reached the Product Planning Dept. realistic corrections were made.

Then there was the manufacturer of zinc-plated steel parts who ran into an epidemic of poor plating and rejects and arbitrarily ordered his shop to over-plate. Several years later when new management took over it discovered that reasonable quality control procedures could have eliminated the rejects and need for over-plating. And the resultant savings would have paid for the

quality control measure many times over.

Many other examples could be cited—such as specifying fluorocarbon plastic seals when ordinary rubber would do, or using high quality admiralty brass when commercial brass fittings would do. In all of the above instances economy lost out at the expense of more than meeting other demands.

Underdesign: cheap but unsafe

Underdesign and product failure go hand in hand. Some of the most dramatic examples of underdesign are those where the product proved unsafe. Designing a safe product involves a thorough knowledge of service demands and some imaginative thinking about unlikely, but possible, demands.

For example, a manufacturer of toy hobbyhorses supported the child's seat and handle on a flexible steel strip one end of which was fastened to the steel frame. A number of cases of strip breakage and children spilling resulted in one parent's sending a unit to our laboratories for evaluation. After a relatively small number of cycles fatigue set in and the strip snapped. This is a case where the requirements of safety and durability overlapped.

Similarly, a manufacturer of baby furniture decided to introduce his products in a new geographical area. Luckily, a major department store decided to conduct an independent evaluation of his line. His products were good except for the bassinette. Every part of this was good too, except the bottom of thin fiberboard which broke when a replica of a baby was dropped from about 2 ft into the bassinette—an accident that could easily happen. Here the demands of safety in the improbable, but possible, area were not met.

Watch out for carry-over specs

Sometimes specs are carried over from previous designs or are pieced together from related products. Such practices can be costly.

For example, a mattress manufacturer had an overall spec for the various materials of his product. The spec for the springs was taken from a product with far more severe service requirements than his mattresses. With the heavy duty springs his mattresses cost more than they should have.

Changing requirements can cause trouble

In today's fast-changing markets new applications are constantly being found for materials. These new applications create new requirements and negate old requirements. An alert manufacturer should constantly check his material specifications if he wants to take competitive advantage of change.

An example of this problem is a plastics manufacturer who was supplying a plastic with excellent dielectric properties to extruders of insulation. As time went by, higher environmental demands made his material obsolete for insulation and he had to turn his business towards consumer products. Evaluation of his material showed that it could satisfy the specifications for shower curtains requiring high strength and tear resistance. It also showed that he could cut costs if he eliminated the specs on high dielectric properties which were obviously no longer required.

A contrasting situation occurred when a manufacturer of plastic upholstery fabric neglected to include in his specification requirements for resistance to light aging and hot and cold weathering. He had always made indoor furniture upholstery and these properties had never been necessary. But when he started making outdoor furniture he soon ran into severe trouble due to cracking, discoloration and plasticizer migration. As a result he had to take the product off the market and work out new specs to provide resistance to environmental conditions.

Prepare to use alternate materials

Unnecessary delay and hardship are often caused by an unwillingness to specify suitable alternate materials. For example, a process equipment fabricator agreed to make a 304 stainless steel pressure vessel for a large chemical manufacturer. Unfortunately, the supply of 304 stainless ran out and the fabricator substituted 316 stainless—at no extra cost to the customer. The vessel was rejected by the customer even though 316 stainless would do all and more than the 304 stainless would do.

Don't ignore specs altogether

Many manufacturers are still willing to take the risk of buying materials without any formal specifications at all. This practice can lead to disastrous results.

A good example of what can happen is a handbag manufacturer who introduced a new handbag with a simple and conventional design: plastic sheet glued over a metal frame. The plastic used was obtained from a supplier with whom the manufacturer had been dealing for some time with satisfactory results.

One day the manufacturer started receiving complaints from a retail outlet: the plastic was letting loose from the metal frame. When other stores started to complain he sent several samples to our laboratories for evaluation. Analysis showed that in order to make a thin sheet of plastic the plastic supplier had added a considerable amount of plasticizer. At the temperature in the retail store the excess plasticizer bled out and combined with the latex of the adhesive to form a tacky mess. Accelerated testing at the early stages would have avoided this problem and produced a meaningful materials specification.

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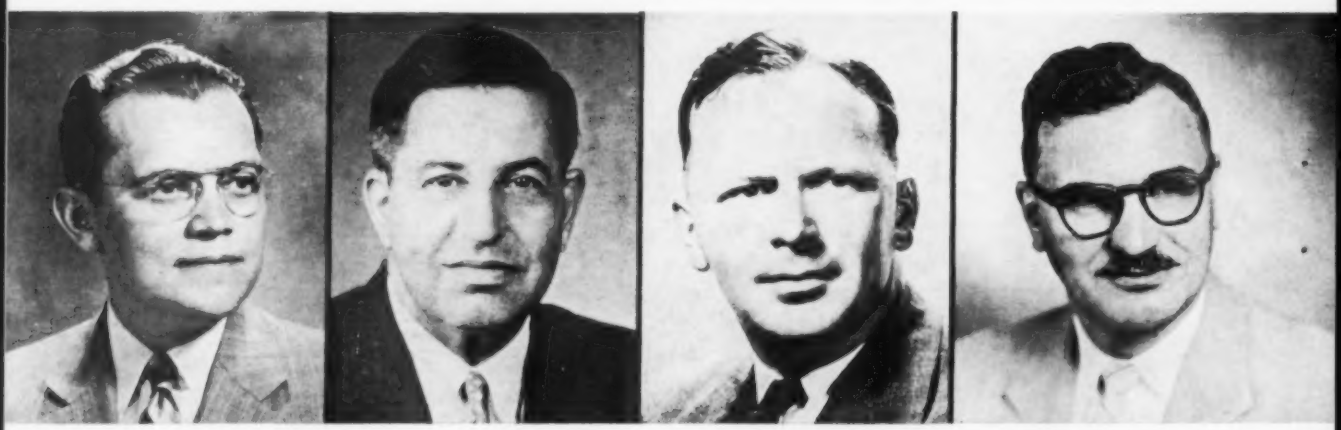
Award Winners will be published. The award-winning entries will be published in the May Design Engineering Show Issue of **Materials in Design Engineering.** Some non-winning entries will also be published in subsequent issues and paid for at the usual rate.

To encourage sound, imaginative and progressive use of engineering materials in industrial and consumer products, **Materials in Design Engineering** each year sponsors an Awards Competition for Best Use of Engineering Materials. The entries in these annual competitions are reviewed by a distinguished board of judges.

BOARD OF JUDGES



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it's easy for you to enter...

here's how:

3 2 1

Simply select your best work of 1960

You can enter any part or product which you worked on, provided that: 1) You are employed in the product manufacturing industries, and 2) The design was completed during 1960 or the product went into production during 1960. An entry may be either a new product or a redesigned product that demonstrates sound, imaginative and progressive use of engineering materials. Engineering materials are defined as metals, nonmetallics, finishes and coatings, and material forms (such as castings, forgings, moldings, etc.). The product may be a complete assembly, a subassembly, a single part or a component.

Prepare your entry – it's easy

You need not write up your entry in the form of an article. Entries will not be judged for literary quality. See back page of this folder for details on the information that must be submitted with each entry.

Send in your entry by February 1

Entries must be mailed no later than February 1, 1961. Mail all entries to

Awards Editor | **Materials in Design Engineering**
430 Park Avenue
New York 22, New York

Here are last year's winners...

W. G. McKenzie, R. D. Ritter
Walker Mfg. Co.
Automatic Lubricator

T. S. Simms, R. B. Snyder, A. Harder, B. Nozaki
Hotpoint Co.
Refrigerator Insulation System

R. F. Summers
Convair
Jet Door Seal

Randolph Research Co.
Laminated Bearing for Helicopter

T. Barabutes
Newark Meter Div., Westinghouse Electric Corp.
Watt Transducer

J. H. Holley, R. Y. Scrapple
Hughes Aircraft Co.
Flexible Wave Guide

T. P. M. Rouse, Jr.
U.S. Naval Underwater Ordnance Station
Externally Pressurized Vessel Design

W. T. Millis, J. F. Stephens, J. G. Tucker
Receiving Tube Dept., General Electric Co.
Composite Metal Tube Cathode

A. H. Gorey
Graflex, Inc.
Camera Shutter

J. L. Hessburg, Jr.
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Trailer Tanks

Development and Design Div.
Ansul Chemical Co.
Fire Extinguisher

General Ceramics Div.
Indiana General Corp.
Computor Memory Stack

Laboratory Instrumentation Dept.
AiResearch Mfg. Co.
Force Ring Transducer

A. Kernick
Small Motor Div., Westinghouse Electric Corp.
Nylon Rack for Computor

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H. E. Dunlap
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Engineering Dept.
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ENTRY FORM

ENTRY FORM

Materials in Design Engineering

5th ANNUAL AWARDS COMPETITION

for the Best Use of Engineering Materials

SPONSORED ANNUALLY BY MATERIALS IN DESIGN ENGINEERING • A REINHOLD PUBLICATION

Eligibility

Any person(s), department, group, or organization in the product manufacturing industries may submit an entry or entries. No one employed by a materials producer or supplier is eligible.

Preparation of Entries

1. The following information must be provided with each entry in order to allow the judges to make competent decisions:

a. A detailed description of the product including photographs or drawings. If the entry is a redesign, provide before and after illustrations if possible.

b. A description of requirements in service and/or fabrication that must be met by the product and the material.

c. A description of the previously used materials (if entry is a redesign).

d. A description of the material or materials selected for the product entry.

e. An explanation of why the material or materials were selected for the product. Describe the advantages or benefits gained through the choice. Back them up with evidence—facts, data, charts, tables on performance, quality or cost.

In general, entries should show that the materials selected for the product—

Resulted in improved performance and/or lower costs or
Best met the design and service requirements.

Here are a few ways in which a product can benefit from intelligent materials selection:

Long service life	Reduced scrap
Lower basic materials cost	Reduced or eliminated maintenance
Less material required	Permitted lower cost design
Improved appearance	Allowed greater design flexibility
Permitted a new design	Simplified production and fabrication
Reduced production costs	
Improved service performance	

Remember! The more detailed and documented your entry is, the more consideration it will receive from the judges.

2. Entries or portions of entries will not be returned unless requested. Entries should not include valuable papers or other material which must be returned, because there is always some danger of loss or mutilation. Whenever possible, photostats, photographs or other copies of such materials should be used instead.

3. All entries must be postmarked not later than **February 1, 1961.** The judges reserve the right to withhold awards at their discretion.

Publication of Entries

Materials in Design Engineering plans to publish articles on the winning entries and reserves the right to publish articles based on entries not winning awards.

NOTE: Please observe the rules given above. Use a separate blank for each entry; additional entry blanks available on request. Attach entry blank below, or its equivalent, to your entry and mail to:

Awards Editor, Materials in Design Engineering, 430 Park Ave., New York 22, N. Y.

Name _____ Title _____

Name(s) of person(s), group or organization who would receive award _____

_____

Company _____

Street address _____ City _____ State _____

Name or brief description of product being entered _____

_____

Was design (or redesign) of entry either completed or placed in production during 1960? _____

Does your employer consent to entry under terms of this competition? _____

Guide to Ferrous Castings

by Donald Peckner, *Associate Editor, Materials in Design Engineering*

ABOVE: DIFFERENTIAL HOUSING OF FORD FALCON IS CAST IN MALLEABLE IRON. FRONT COVER: 'MOON' SURFACE IS MAGNIFIED VIEW OF GRAY IRON SURFACE. CASTING FURNISHED COURTESY OF ACME TOOL CO., NEW YORK CITY.

Depending on the alloy selected, ferrous castings can offer outstanding strength; resistance to heat, corrosion or wear; mass; or magnetic properties. For some of you the text will be a concise introduction; for many a helpful review. But all engineers will find the accompanying standard data on all ferrous casting alloys, collected from many different sources, a valuable and convenient reference. The manual discusses:

- *The four main groups of alloys*
- *How to pick the right alloy for a particular service condition*
- *The principal molding and casting methods*
- *Designing ferrous castings*

Ferrous casting alloys present the design engineer and materials engineer with a broad spectrum of compositions which can be applied at temperatures ranging from cryogenic up to 2100 F. Mechanical and physical properties of the alloys cover a wide range: yield strengths, for example, can range from 20,000 psi up to 170,000 psi and modulus of elasticity from 12×10^6 psi up to 30×10^6 psi (see Table 1). This manual will introduce (or reintroduce) designers and materials engineers to the ferrous casting alloys, the casting processes, and the important design considerations. In addition, it presents specific property data in six important application areas. With this information, many engineers will have a firmer basis on which to discuss their problems with the foundryman. Even those who are more familiar with ferrous castings should find the comprehensive collection of data convenient as a ready reference source.

Working with the foundryman: the key to success

Obtaining castings is a simple task. Foundries, both captive and independent, are readily available to assist the designer and materials engineer in every part of the country. Because they are used so frequently and are a common industrial form, there is, perhaps, a tendency to regard castings with a feeling that, "Here is something that doesn't require a large expenditure of energy. Given a pattern and some sand, our needs can be fulfilled."

The giant advances in the foundry industry antiquate this approach to castings. New techniques, improved casting compositions, broad design information—all can be used by the foundry engineer to help designers and materials engineers obtain the castings they need. The quality of the castings will be better today than at any time in the past, and the broad research programs of the foundry industry hold promise of improving quality even further in the future.

TABLE 1—GENERAL SURVEY OF SOME MECHANICAL AND PHYSICAL PROPERTIES OF CAST FERROUS ALLOYS

Type →	Gray Cast Iron	Malleable Irons	Ductile Iron	Carbon and Low Alloy Steel
Ten Str, 1000 psi	20-80	48-120	60-160	60-200
Yld Str, 1000 psi	15-60	30-95	40-135	30-170
Compr Str, 1000 psi	3-5 x ten str	48-95	40-135	60-200
Shear Str, psi	1-1.6 x ten str	~ 0.9 x ten str	0.9 x ten str	—
Elong (in 2 in.), %	0-3	1-26	1-26	5-35
Mod of Elast, 10^6 psi	12-22	25	24-26	30
Density (68 F), lb/in.^{3}	0.25-0.266	0.258-0.274	0.25-0.28	0.282-0.284
Coef of Ther Exp, 10^{-6} in./in.	5.8 (32-212 F)	6.6 (70-750 F)	7.5 (70-1100 F)	6.1-7.1 (90-415 F)
Elec Res (68 F), microhm-cm	75-120	28.8-34.4	55-70	14-17

Source: *Cast Metals Handbook*, American Foundrymen's Society, 1957.

Engineers responsible for obtaining castings should adopt the attitude that foundries be consulted before a design concept is frozen. To take full advantage of the casting process:

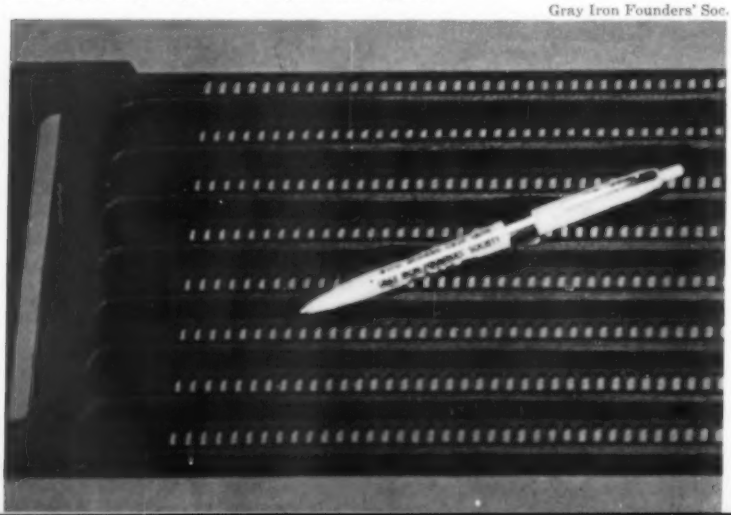
1. Design a component specifically as a casting rather than a conversion from other fabricating techniques.

2. In order to get the best material for the job, at the lowest cost, determine the full extent of the materials problem—what is really the end use of the casting, what environment will it operate in, etc.

3. Discuss the type of casting process to use with the foundry engineer before making a final decision. Often, a designer may feel that a particular casting process should be used. The foundry may resist his choice because from experience it can suggest more reasonable alternatives. Fig 1 shows a grid casting that was originally designed for the shell molding process. Clearances could not be maintained until the unit was cast in a green sand mold.

1—*Originally designed for shell molding, this grid casting had to be switched to the green sand process. Shell mold could not maintain clearances; green sand had enough "give" to do job successfully.*

Gray Iron Founders' Soc.



Ferrous casting alloys: the four main groups

These alloys are generally grouped into four broad categories: cast irons (gray, white and high alloy), malleable irons (standard and pearlitic), ductile irons, and cast steels.

Relative ease of casting complex shapes ranges from simple to difficult in the following order: low strength gray iron, high strength gray iron, ductile iron, white iron, regular malleable iron, pearlitic malleable iron, carbon steel, very low carbon steel and high alloy steels.

1. Cast iron

Essentially an alloy of iron, carbon and silicon in which carbon is present in excess of the amount that can be retained in solid solution in austenite at the eutectic temperature. When cast iron contains one or more specially added elements in amounts sufficient to produce a measurable modification of the physical properties of the section under consideration, it is called alloy cast iron. Silicon, manganese, sulfur and phosphorus, as normally obtained from raw materials, are not considered alloy additions.

a. *Gray cast iron*—Cast iron which contains a relatively large percentage of its carbon in the form of graphite, and substantially all of the remaining carbon in the form of eutectoid carbide. The material has a gray fracture It offers excellent casting characteristics, low cost, good wear resistance and machinability, and excellent damping capacity. Its properties (Table 2) are dependent primarily on composition, and to some extent on cooling rate.

b. *White cast iron*—Cast iron in which substantially all of the carbon is present in the form of iron carbide. It has a white fracture.

c. *High alloy irons*—Irons containing sufficient alloy content (usually more than 3%) so that their properties are not characteristic of the regular irons. The various high alloy irons are generally used for the specific properties in which they are outstanding; i.e., corrosion resistance wear resistance or heat resistance

2. Malleable irons

Standard and pearlitic malleable irons offer a wide range of yield strengths (Table 3) combined with appreciable ductility. Properties can be precisely controlled by heat treatment. As a result, effect of section size is minimized.

a. *Standard malleable iron*—Obtained by a heat treatment of white cast iron which converts substantially all of the combined carbon into nodules of graphite

b. *Pearlitic malleable iron*—Obtained by a heat treatment of white cast iron which converts some of the combined graphite into graphite nodules but leaves a significant amount of combined carbon in the product.

TABLE 2—SUMMARY OF GRAY IRON SPECIFICATIONS

Specification ↓	Class	Min Tensile Str, psi	Brinell Hardness	Use
ASTM A190-47	—	—	—	Where strength and microstructure are not a prime requisite
ASTM A48-60	20	20,000	—	General castings not covered by other specifications and in which strength is a consideration ↓
	25	25,000	—	
	30	30,000	—	
	35	35,000	—	
	40	40,000	—	
	45	45,000	—	
	50	50,000	—	
	60	60,000	—	
ASTM A159-55 SAE (Individual spec number given in Class column)	110	20,000[a]	187 max[a]	Automotive gray iron castings ↓
	111	30,000[a]	170-223[a]	
	113	30,000[a]	179-229[a]	
	114	40,000[a]	207-269[a]	
	120	35,000[a]	187-241[a]	
	121	40,000[a]	202-255[a]	
	122	45,000[a]	217-269[a]	
ASTM A278-56	40[b]	40,000	—	Pressure-containing parts for use at 450 to 650 F[b] ↓
	50	50,000	—	
	60	60,000	—	
ASTM A319-53[d]	I	Deliberately soft, low strength[c]	—	For superior thermal shock resistance ↓
	II	Above 30,000 may be expected[c]	—	For average thermal shock and moderate strength
	III	As high as 40,000 may be expected	—	For higher strength (at temperature)
U. S. Navy 46-1-9	—	25,000	120-180	High alloy scale-resisting castings ↓
U. S. Military MIL-G-858A	I	25,000	120-180	High alloy for resistance to corrosion, scaling, warpage and growth
	II	25,000	120-180	

[a]Properties in 1.2-in. dia test bar unless otherwise specified.
[b]Classes 20 through 35 are also covered but limited to use below 450 F.
[c]Low strength iron is desired for thermal shock resistance. Where strength is essential, tensile strength may be specified.
[d]Non-pressure-containing parts for elevated temperatures.
Source: Gray Iron Founders' Society.

3. Ductile iron

Similar in composition to gray iron. An innoculant, usually magnesium, permits formation of spherulitic graphite in place of the flake graphite found in gray iron.

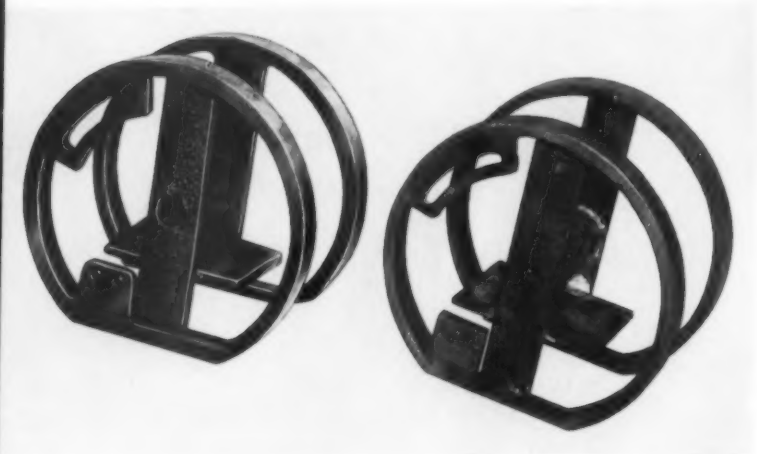
Ductile and malleable irons actually fill the gap between gray

Gray Iron Founders' Soc.

Broach holder *used for finishing titanium air compressor blades was made more rigid by using a ductile iron casting (class 80-60-03).*

Malleable Founders' Soc.

Hose fitting *of malleable iron shown at left is swaged around rubber hose. Malleable castings can be easily and effectively cold formed.*



Gray Iron Founders' Soc.

Type cylinder *at left is gray cast iron. Substituting gray iron for welded fabrication (right) reduced costs 87% and increased machinability.*

TABLE 3—STANDARD AND PEARLITIC MALLEABLE IRONS (Minimum Mechanical Properties)

Grade ⬇	Ult Str, 1000 psi	Yld Str, 1000 psi	Elong (in 2 in.), %
STANDARD[a]			
32510	50	32.5	10
35018	53	35	18
PEARLITIC[b]			
45010	65	45	10
45007	68	45	7
48004	70	48	4
50007	75	50	7
53004	80	53	4
60003	80	60	3
80002	100	80	2

[a]Spec ASTM A47. [b]Spec ASTM A220.
Source: Malleable Founders' Society.

TABLE 4—STANDARD GRADES OF DUCTILE (NODULAR) IRON

Grade ⬇	Applicable Specifications	Mechanical Properties (min)		
		Ten Str, 1000 psi	Yld Str, 1000 psi	Elong (in 2 in.), %
60-45-10	ASTM A339-51T MIL-I-11466, Class 5	60	45	10
80-60-03	ASTM A339-51T MIL-I-11466, Class 4	80	60	3
100-70-03	MIL-I-11466, Class 2	100	70	3
120-90-02	MIL-I-11466, Class 1	120	90	2

Source: Gray Iron Founders' Society.

cast iron and steel. The mechanical properties of ductile iron (Table 4) are similar to those of pearlitic malleable irons. The difference between the two types is this: section size for ductile iron castings is not limited, as is the case with malleable iron. Soundness and casting properties of ductile iron are maintained even in heavier sections.

4. Cast steels

Alloys of iron, carbon and other alloying elements. Current specifications for cast steels are noted in Tables 5 to 7.

The large variation in properties of steel castings, as seen in these three tables, is made possible through control of the composition and by heat treatment. Steel castings are ductile and tough, as well as strong. In addition, the carbon and low alloy steels are freely weldable, a feature that is often important to designers and process engineers.

TABLE 5—CARBON AND LOW ALLOY CAST STEELS
(Minimum Mechanical Properties)

Spec	Class	Heat Treatment[a]	Tensile Strength, 1000 psi	Yield Point, 1000 psi	Elongation (in 2 in.), %
ASTM A27-58	N-2	A, N, NT, QT	—	—	—
	N-3	↓	—	—	—
	U-60-30		60	30	22
	60-30	A, N, NT, QT	60	30	24
	65-30		65	30	20
	65-35		65	35[c]	24
	70-36		70	36	22
	70-40		70	40	22
ASTM A148-58	80-40	A, N, NT, QT	80	40	18
	80-50		80	50	22
	90-60		90	60	20
	105-85		105	85	17
	120-95		120	95	14
	150-125		150	125	9
	175-145		175	145	6
ASTM A216-58T	WCA	A, NT	60	30	24
↓	WCB	↓	70	36	22
ASTM A217-58T	WC1	A, NT	65	35	24
	WC4		70	40	20
	WC5		70	40	20
	WC6		70	40	20
	WC9		70	40	20
	C5		90	60	18
	C12		90	60	18
ASTM A352-58T	LCB[d]	N, NT, QT	65	35	24
	LC1[d]		65	35	24
	LC2[d]		65	40	24
	LC3[d]		65	40	24
ASTM A356-58T	1	NT	70	36	20
	2		65	35	22
	3		80	50	18
	4		90	60	16
	5		70	40	22
	6		70	45	22
	7		70	40	22
	8		80	50	18
	9		95	60	15
	10		85	55	20
ASTM A389-57T	C23	1850N + 1250T (min), 1 hr/in.	70	40	18
	C24	1850N + 1250T (min), 12 hr	80	50	15

[a]Alternate heat treatments listed. Key: A—full annealed; N—normalized; T—tempered; Q—liquid quenched.
[b]Hardness tests when specified in contract order.
[c]If full anneal specified, 33,000 psi yield required.
[d]Min Charpy keyhole impact notch of 15 ft-lb required at temperature specified by customer. Test temperatures and grades are: —50 F, LCB; —75 F, LC1; —100 F, LC2; —150 F, LC3

TABLE 6—CORROSION RESISTANT CAST STEELS
(Representative Mechanical Properties)

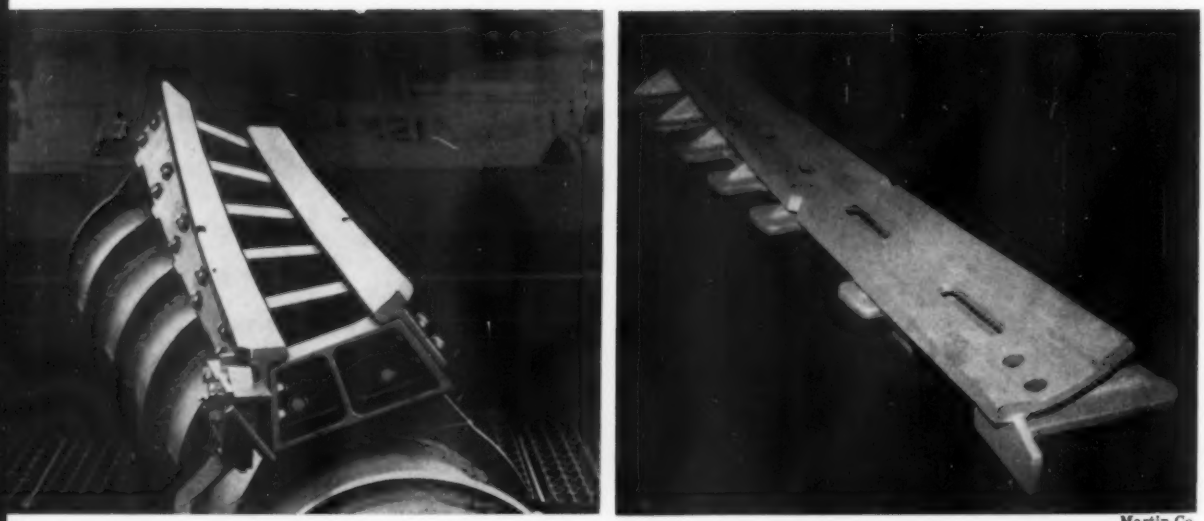
ACI Spec ↓	Ten Str, 1000 psi	Yld Pt, 1000 psi	Elong (in 2 in.), %
CA-15	200[a]	150	7
CA-40	220	165	1
CB-30	95[b]	60	15
CC-50	97[c]	65	18
CE-30	97[d]	63	18
CF-8	77[d]	37	55
CF-20	77[d]	36	50
CF-8M, CF-12M	80[d]	42	50
CF-8C	77[d]	38	39
CF-16	77[e]	40	52
CH-20	88[e]	50	38
CK-20	76[e]	38	37
CN-7M	69[e]	31	48
CF-3	77[e]	37	55
CF-3M	80[e]	42	50
CG-8M	82[e]	43	50
CD-4MCu	105[e]	85	25

Heat treatments: [a]Air cooled from 1800 F, tempered at 600 F; [b]annealed at 1450 F, furnace cooled to 1000 F, air cooled; [c]air cooled from 1800 F, tempered at 1400 F; [d]as cast; [e]water quenched from 2000 F.
Source: Alloy Casting Institute.

TABLE 7—HEAT RESISTANT CAST STEELS
(Representative Mechanical Properties)

ACI Spec ↓	Ten Str, 1000 psi	Yld Pt, 1000 psi	Elong (in 2 in.), %
HA	95	65	23
HC			
[a]	70	65	2
[b]	110	75	19
HD	85	48	15
HE	95	45	20
HF	85	45	35
HH	80	50	25
HI	80	45	12
HK	75	50	17
HL	82	52	19
HN	68	38	17
HT	70	40	10
HU	70	40	9
HW	68	36	4
HX	65	35	9

[a]Under 1% Ni, low N.
[b]Over 2% Ni, 0.15% N min.
Source: Alloy Casting Institute.



Martin Co.

Missile launcher, *a nine-part fabricated assembly, was redesigned as a casting, shown at right. The change increased dimensional stability and saved $1335 per launcher.*

Know the service conditions—then pick the material

Usually, a design has one limiting factor that governs the choice of casting alloy. At times the limiting factor is a simple one. Many castings are required simply to supply a large weight or accurately position a hole. In such cases the least expensive material, such as gray iron or plain carbon steel, can be chosen with expectations of successful performance.

At other times the engineer must decide on the need for heat resistance, ability to operate at low temperatures, ductility requirements, etc. In many instances the designer will find that one material will carry several burdens.

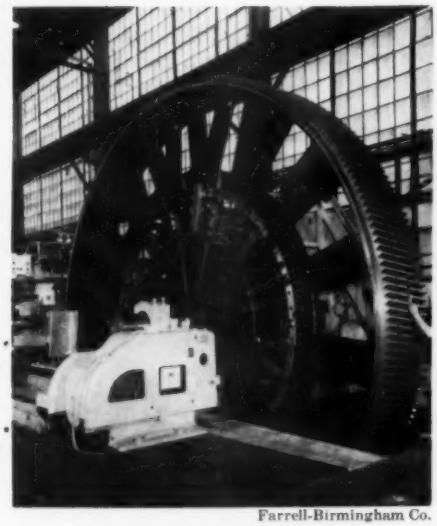
TABLE 8—HEAT RESISTING FERROUS ALLOYS
(Maximum Operating Temperature, F)

Cast Steel (low carbon)	600
Gray Cast Iron	600-750
White Cast Iron	600-750
Cast Steel (medium carbon)	700
Malleable Iron (all)	800
Ductile Iron	800
Cast Steel (low alloy)	1100
HA	1200
HF	1200-1600
HC	1200; 2000[a]
Gray Cast Iron + 1.5% Cr	1600
HD	1800
HL	1800
HH	2000
HE	2000
HU	2000
HW	2050
HN	2100
HT	2100
HX	2100
HK	2100
HI	2150

[a]For moderate load bearing service, 1200 F max; for oxidation resistance in high sulfur atmosphere, up to 2000 F.
Source: Alloy Casting Institute.

TABLE 9—STRESS-RUPTURE PROPERTIES OF SOME FERROUS CASTING ALLOYS
(100-Hr Rupture Stress, 1000 psi)

Temp, F ➡	800	1000	1200	1400	1600	1800	2000
HA	—	37	—	—	—	—	—
HC	—	—	—	3.3	1.7	0.85	—
HD	—	—	—	10	5	2.5	—
HE	—	—	30	11	5.3	2.5	—
HF	—	—	—	14	6.0	—	—
HH	—	—	—	14	6.4	—	1.5
HI	—	—	—	13	7.5	—	1.9
HK	—	—	—	14.5	7.8	—	2.5
HL	—	—	—	15.0	9.2	—	—
HN	—	—	—	—	9.5	—	2.5
HT	—	—	—	—	8.5	—	2.5
HU	—	—	—	15	8.0	—	—
HW	—	—	—	10	6	—	—
HX	—	—	—	13	6.7	—	1.7
Malleable Iron							
Standard	30.0	9.0	4.0	—	—	—	—
Pearlitic	32.5	15.0	—	—	—	—	—
Gray Cast Iron	42.5	24.6	4.5	—	—	—	—
Ductile Iron							
80-60-30	47	17	4.3	—	—	—	—
60-45-10	32.5	10	3.3	—	—	—	—
Cast Steel							
Low Carbon	—	15	5	1.5	—	—	—
Low Alloy	68	41	—	—	—	—	—



Farrell-Birmingham Co.

***Single helical split ring gear** is largest ever cast in alloy steel. Finished weight, 85,000 lb; diameter, 23 ft; face width, 30 in.*

This is particularly true in the area of heat and corrosion resistance.

When you need heat resistance . . .

This specification area requires careful examination. When exposure to elevated temperatures is involved, the tendency of the designer to over-specify is strong, even though the casting with the highest amount of alloy additions is not necessarily the best one for the job. For any given temperature range below 2150 F, a casting alloy can be chosen that will perform satisfactorily. The alloy may not perform well at slightly higher temperatures, but it is usually less expensive than alloys that offer the designer too great a safety factor. Over-specifying can become particularly costly when highly alloyed heat resistant steels or cast irons are specified for temperature ranges where gray iron or malleable iron will perform well.

Table 8 lists maximum service temperatures for ferrous casting alloys ranging from gray iron to the highly alloyed, heat resistant materials. In narrowing the choice of materials, two further points should be considered.

1. Operating temperature must be known with some degree of certainty. Occasional temperature excursions, if of short duration, may possibly be discounted. Metallurgical changes in ferrous alloys do not take place instantaneously but rather over a period of time.

2. Operating stress should be

TABLE 10—GENERAL CORROSION CHARACTERISTICS OF FERROUS CASTING ALLOYS

Gray Cast Iron	More res to some types of corr than carbon and low alloy steels, possibly because of graphite; e.g., cast iron soil pipe usually lasts longer than steel pipe. Res to strong sulfuric acid, cold conc phosphoric and nitric acids. Also res to many alkalis including sodium hydroxide, soda ash and ammonia
Malleable Iron	Res to atm corr in rural, industrial and marine environments, fresh and salt waters
Ductile (nodular) Irons	Approx same corr res as gray irons of similar comp
Cast Carbon and Low Alloy Steels	Corr characteristics approx the same as for wrought steels of same comp
CAST STAINLESS STEELS	
CA15, CA40	Good atm corr res. Excellent res to many organic media in rel mild svc
CB30	Res nitric acid, alkaline solutions, many organic chemicals, oxidizing atm up to 1400 F
CC-50	Excellent res to dil sulfuric acid in mine waters, mixed nitric and sulfuric acids, and oxidizing acids of all types
CE-30	Particularly res to sulfurous acid, mixtures of dil sulfuric and sulfurous acids, sulfuric and nitric acids, and sulfites
CF-8	Res strongly oxidizing media such as boiling nitric acid, sulfuric acid and sulfates, and organic acids
CF-20	Similar to CF-8 but used under less drastic condns
CF-8M, CF-12M	Res reducing media. More res to pitting corr than CF-8 in contact with chlorides. Not as res to boiling nitric acid as CF-8
CF-8C	Similar to CF-8
CF-16F	Similar, but somewhat inferior, to CF-8
CH-20	Res to hot dil sulfuric acid. Superior to CF-8 in certain media
CK-20	Similar to CH-20 but better res at elev temp
CN-7M	Res sulfuric acid and many reducing chemicals. Good res to dil hydrochloric acid and salt solutions
CF-3, CF-3M, CD-4MCu	Similar to CF-8
CG-8M	Similar to CF-8 but preferred in reducing environments
HIGH ALLOY CAST IRONS	
Ni-Resist	For many solutions, corr res is as good as, or better than, that of phosphor bronze
High Silicon Cast Iron	Good res to sulfuric and nitric acids at all conc and temp. Res to organic acids but inferior to gray iron in presence of alkalis
High Chromium Cast Iron	Excellent for oxidizing acids such as nitric acid. Reducing acids or presence of chlorides breaks down protective surface film. Practically immune to corrosion by aerated sea water and most mine waters

Source: *Materials Selector* issue, M/DE, Vol. 52, No. 6, to be published mid-Nov., '60.

TABLE 11—IMPACT PROPERTIES OF SOME CAST FERROUS ALLOYS BELOW ROOM TEMPERATURE

Material	Composition, %					Condn	Temp, F	Impact, ft-lb	
	Total C	Comb C	Si	Mn	Other			Charpy	Izod
Gray Cast Iron	3.42	1.07	1.2	0.5	—	As Cast	RT −4 −112	14.5 13.5 12.1	— — —
Alloy Gray Cast Iron	2.76	—	2.0	—	Ni 1.7	As Cast	RT −45	— —	44 38
	2.73	—	1.6	—	Ni 13.8, Cr 2, Cu 6	As Cast	RT −45	— —	55[a] 50[b]
Malleable Cast Iron	3.05	—	0.8	0.5	—	Ann.	RT −51 −78	4 3 3	— — —
Carbon Steel	—	0.14	0.4	0.7	—	Hard. and Temp	RT −13 −36 −51 −78	38[b] 16[b] 10[b] 7[b] 3[b]	— — — — —
Mn-Mo Steel	—	0.33	0.6	1.4	Mo 0.3	Hard. and Temp	RT −4 −40 −94 −148	30[c] 28[c] 28[c] 19[c] 15[c]	— — — — —
Cr-Mo Steel	—	0.30	0.3	0.7	Cr 0.8, Mo 0.2	Hard. and Temp	RT −4 −49 −94 −184	43[c] 38[c] 38[c] 29[c] 17.5[c]	— — — — —
Ni Steel	—	0.12	0.3	0.6	Ni 1.0	Norm. and Temp	RT −51 −99 −148 −202	73[b] 23[b] 8[b] 2[b] 1[b]	— — — — —
	—	0.10	—	0.7	Ni 2.5	As Cast	RT −114	— —	72 17
	—	0.11	0.3	0.6	Ni 5.0	Norm. and Temp	RT −51 −99 −148 −202	54[b] 54[b] 15[b] 6[b] 4[b]	— — — — —
	—	0.13	0.25	0.80	Ni 9.0	Norm. and Temp	RT −108 −314	44[c] 41.4[c] 22.6[c]	— — —
Ni-Mo Steel	—	0.3	0.4	0.7	Ni 1.7, Mo 0.3	Norm.	RT −4 −49 −94 −184	15[c] 14[c] 10[c] 7[c] 4[c]	— — — — —
Ni-Cr Steel	—	0.26	0.4	0.7	Ni 1.1, Cr 0.7	Hard. and Temp	RT −4 −94 −184	24[c] 22[c] 14[c] 8[c]	— — — —
Ni-Cr-Mo Steel	—	0.26	0.4	0.6	Ni 1.8, Cr 0.6, Mo 0.3	Hard. and Temp	RT −4 −49 −184	33[c] 32[c] 29[c] 25[c]	— — — —

[a]Unnotched. [b]V-notch. [c]Keyhole notch.

carefully calculated so that creep rate or rupture strength can be determined. At elevated temperatures, especially, the effect of stress is deleterious if the ferrous casting alloy chosen has a high creep rate or low rupture strength at operating temperatures. Rupture stresses for ferrous alloys vary considerably, as shown in Table 9. If stress is very low, alloy can be chosen on the basis of oxidation resistance.

. . . corrosion resistance

This is another service requirement that often depends on intuitive judgment as well as specific data for a successful solution. Several parameters to consider:

1. Is surface finish a critical factor?

2. How important is corrosion outside the working area?

3. Must the casting maintain tight dimensional integrity over a long period of time?

4. Will corrosion products affect performance?

One item often overlooked in a corrosion situation is the thickness of the cast component. If the projected corrosion rate is not high, the mass of the casting may offset a supposed corrosion problem. In some cases, mass of the casting alone reduces the need for highly alloyed casting alloys. Although the corrosion rate may appear to be high, the large mass prevents effective degradation of properties.

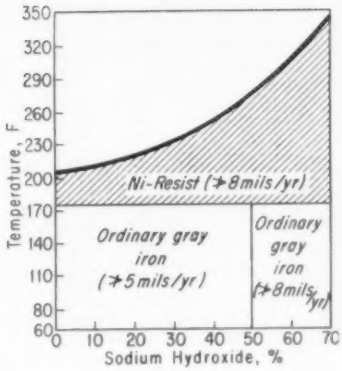
Corrosion resistance of many ferrous casting alloys is summarized generally in Table 10. For example, if a casting must withstand atmospheric corrosion, malleable iron can be considered as well as ACI CA-15, an alloy compounded specifically for corrosion resistance. Each situation must be evaluated in terms of the environment so that satisfactory performance can be obtained at the lowest cost.

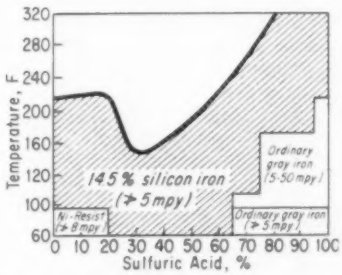
Behavior of several cast irons in particular corrosive environments is shown graphically in Fig 2. An interesting approach to the corrosion problem has been developed in Belgium by *Porbaix*.

TABLE 12—SEVERAL WEAR RESISTANT CAST IRONS

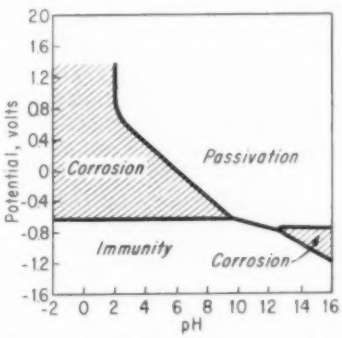
Type	Composition, %							Brinell Hardness Range
	C	Si	Mn	Ni	Cr	Cu	Mo	
Unalloyed Chilled	3.0-3.6	0.5-1.6	0.25-0.70	—	—	Tr	—	350-575
Unalloyed White	2.8-3.6	0.5-1.3	0.4-0.9	—	—	Tr	—	300-575
Ni-Hard	2.8-3.6	0.4-0.7	0.2-0.7	2.5-4.75	1.2-3.5	—	—	525-600
High Chromium	1.8-3.5	0.5-2.5	0.3-1.0	0-5.0	10.0-35.0	0-3.0	0-3.0	250-700
Molybdenum	1.7-3.7	0.3-2.6	0.2-1.5	0-5.0	0-6.0	0-1.5	0.3-12.0	350-700

Source: Gray Iron Founders' Soc.





2—*Corrosion rates of cast iron in sodium hydroxide and sulfuric acid.* (British Cast Iron Research Assn.)



3—*Simplified* Porbaix *diagram for corrosion of iron at 77 F.* (As noted by U. R. Evans)

Using pH value and potential as coordinates to represent the various chemical and electrochemical equilibria that affect corrosion, regions are determined in which immunity, corrosion or passivation may be predicted. A simplified Porbaix diagram for iron is shown in Fig 3.

. . . low temperature service

Principal requirement of ferrous castings intended for low temperature service is the ability to resist brittle fracture. The austenitic irons and steels will generally exhibit a low nil-ductility transition temperature (NDT) and can be used with confidence.

The most commonly used criterion for low temperature service is toughness, or ability to withstand shock loading. Table 11 shows composition and impact properties of many irons and steels at temperatures down to –300 F. These data indicate that many of the irons and plain carbon steels will be unsuitable for cryogenic applications. Low alloy cast steels should be given principal consideration because of their high impact strength at low temperatures.

. . . wear resistance

Work hardening characteristics, high as-cast hardness, and heat treatability, although separate and distinct properties, offer the designer wide latitude in specifying materials for an application in which wear is the principal design criterion.

Ferrous parts can be cast virtually to size and heat treated in several ways: by through hardening, general surface hardening, or selective hardening of specified wear areas. Other parts can be hardened by the working action of the function they perform.

Many of the irons, especially white cast iron, have extremely wear resistant surfaces produced by chilling portions of the casting in the mold. Table 12 notes the composition of several wear resistant cast irons along with the surface hardness normally obtainable with each composition. Thus, the designer can consider several categories of material when wear resistance is required:

1. Hardness obtained as cast. Usually restricted to various cast iron compositions.

2. Hardness obtained by surface hardening. Cast carbon steels, gray irons, ductile irons and malleable irons can be used.

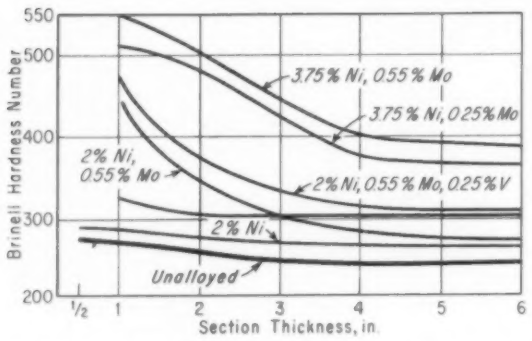
3. Hardness obtained by changing the surface chemically. Cast alloy steels are used in the carburized or nitrided condition.

4. Hardness obtained by heat treatment for uniform properties throughout the casting. The cast alloy steels, gray irons, ductile irons and malleable irons should be considered.

5. Hardness obtained through cold working of the casting surface. The alloy most often used in this case is austenitic manganese steel (Hadfield steel).

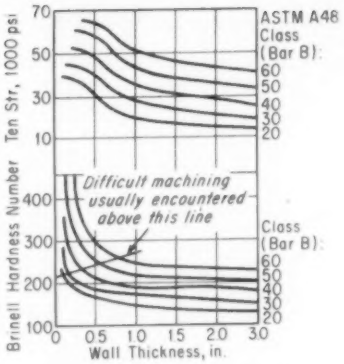
High strength

Ferrous castings offer the designer a convenient means to obtain high strength parts. Eliminating many of the fabricating problems can reduce costs and increase integrity. Because the heat treating characteristics of ferrous



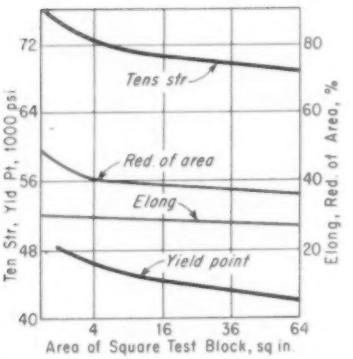
4—*Effect of alloy content and section thickness on the hardness of normalized ductile iron.*

(Isleib and Salvage, *Trans.* AFS, '57)



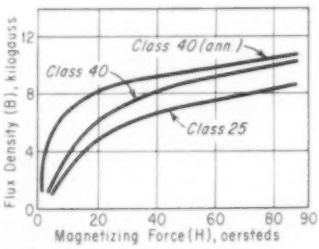
5—*Effect of section thickness on tensile strength and hardness of gray iron castings.*

(Gray Iron Founders' Soc.)



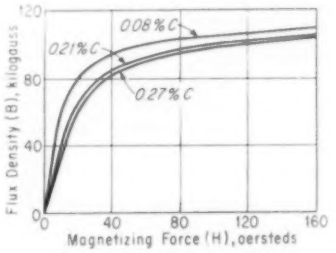
6—*Effect of mass on mechanical properties of an annealed medium carbon steel.*

(Steel Founders' Soc. of America)



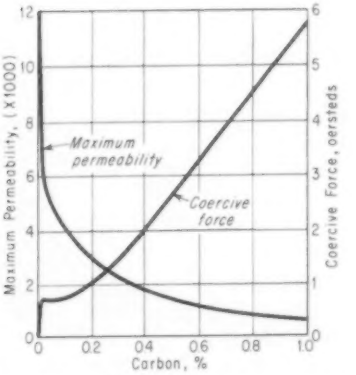
7—*Magnetization curves for several gray irons.*

(Gray Iron Founders' Soc.)



8—*Magnetization curves of annealed plain carbon steel castings.*

(National Bureau of Standards)



9—*Effect of carbon content on maximum permeability and coercive force of annealed carbon steel.*

(Adapted from Yenson)

casting alloys are well-known, the designer can expect to receive these castings with closely controlled mechanical properties. One potential stumbling block: the effect of section size. If this effect is not known precisely, it should be approximated to obtain reasonably realistic design properties. Fig 4, 5 and 6 show graphically the effect of section size for alloys ranging from gray cast iron to cast steel.

Pertinent mechanical properties of the ferrous casting alloys are summarized in Tables 2 to 5.

Magnetic properties

Although their magnetic properties do not approach those of the permanent magnet steels or the commonly used silicon steels, cast irons are widely used where magnetic properties are important. Some advantages are:

1. Iron castings can be made in intricate shapes where steel forgings would be impractical and steel castings difficult to obtain.

2. Magnetic properties of cast iron are less affected by tensile and compressive stresses than are those of steel.

3. Where cast iron has been permanently magnetized the temperature coefficient of loss in magnetism is much smaller than that of magnet steels. Shock losses are also small.

4. Nonmagnetic cast irons are used as structural members in electrical machinery and, because of their low permeability, reduce magnetic leakage.

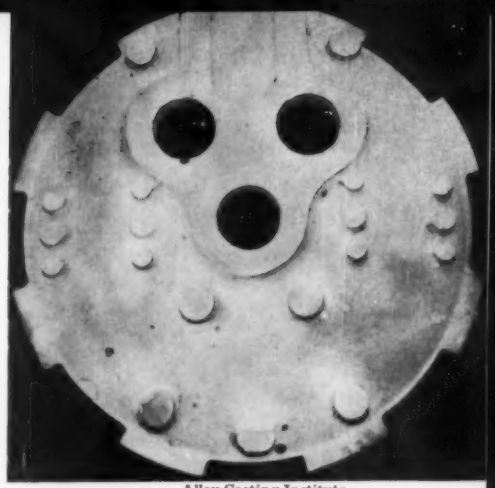
Cast steels are also used for magnetic circuits where a soft magnetic material is required. B-H curves for several grades of cast irons and steels are shown in Fig 7 and 8. Fig 9 shows the effect of carbon content on the magnetic properties of cast carbon steels.

The casting processes: how they differ

Choice of a casting process for producing ferrous castings is wide. Characteristics of the various processes are summarized and compared in Tables 13 and 14. Designers should be generally familiar with the capabilities and limitations of the processes in order to obtain better support from the foundry industry.

Green sand casting—Green sand molding is the method used most frequently. "Green" indicates that moisture is present in the sand and that the mold is neither dried nor baked. This method is not suitable for large or very heavy castings.

Dry sand casting—Most large and very heavy castings are made in dry sand molds. Mold surfaces are given a refractory coating and are dried before the mold is closed for pouring. The mold is thus hardened to provide the strength necessary to resist erosion by large amounts of metal. Manufacturing time is longer than



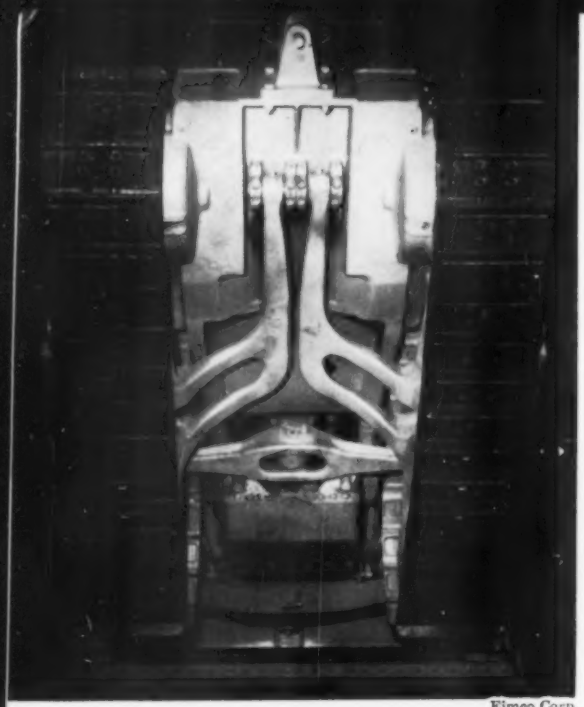
Alloy Casting Institute

Torpedo breech door *for nuclear submarine SS(N) 593,* Thresher, *is cast from ACI type CD-4M Cu precipitation hardening alloy. Casting weight, 250 lb; diameter, 26 in.*

TABLE 13—SUMMARY OF MOLDING AND CASTING PROCESSES

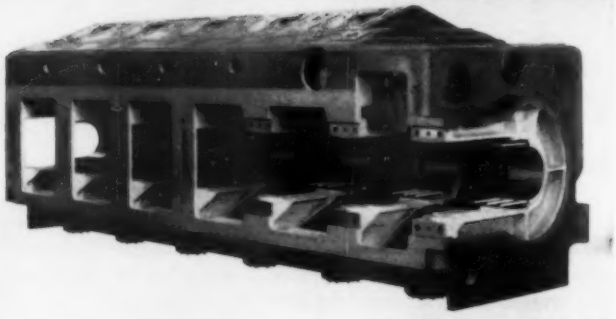
Process →	Green Sand	Dry Sand (oil sand)	Shell	Floor and Pit Molding	Permanent Mold	Investment	Centrifugal
Casting Size, Weight	1 oz to several tons	1 oz to several hundred pounds	1 oz to several hundred pounds	Large, any weight	Several ounces to about 25 lb	Less than 1 oz to several hundred pounds, usually under 10 lb	Up to several hundred pounds
Casting Intricacy External—Mold Surface	Limited by pattern drawing; no limit with cores	No limit	Limited by pattern drawing; no limit with cores	No limit with cores	Limited by casting ejection	Limited to wax patterns that can be ejected from dies	Casting of circular periphery most favorable for centrifugal casting. Any shape can be centrifuged
Internal—Cored Surfaces	No limit	No limit	No limit	No limit	No limit with sand cores	Limited to assemblies of wax patterns that can be ejected from dies	Hollow, circular unless centrifuged in a cored mold
Number of Castings Minimum	One	One	—	One	1000 to 5000	500 to 5000	One or more
Maximum	Pattern life limited	Core box life limited	Pattern life	Pattern life limited	Mold life limited, 1000 to 100,000	Pattern life	Pattern or mold life
Casting Alloys[a]	G, M, S, H&C	G, M, S, H&C	G, M, S, H&C	C, S, H&C	G, S	S, H&C	G, S, H&C
Tendency of Mold to Cause Tearing	Mold and cores can be made collapsible	Mold and cores are collapsible	Mold and cores are collapsible	Mold and cores can be made collapsible	Cores are collapsible	Not as collapsible as sand	
Type of Patterns	Simple wood patterns to machined metal patterns, core boxes	Core boxes and driers	Machines, metal patterns	Usually wood patterns	Machined mold	Metal die for casting wax patterns	Patterns for centrifuged castings. Metal mold for pipe castings or special equipment for making sand-lined pipe casting molds

[a]G—gray iron; M—malleable iron; S—steel; H&C—heat and corrosion resistant alloys.
Source: Adapted from American Foundrymen's Society.



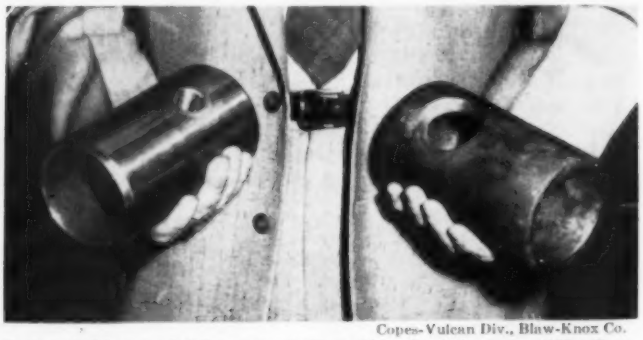
Eimco Corp.

Diagonal braces *in tractor are integrally cast with a track roller frame. The steel castings absorb impact loads. The design allows stresses to "flow" evenly throughout structure.*



Cooper-Bessemer Corp.

50,000-lb crankcase *for gas engine is cast in Meehanite.*



Copes-Vulcan Div., Blaw-Knox Co.

Retractable soot blowers *shell molded in ACI type HH alloy withstand 2300 F and thermal shock from high velocity steam.*

for green sand casting. Molds hardened by the CO_2 process are considered to be dry sand molds.

Core mold casting—Castings of unusual complexity (such as the thin, deep fins of an air-cooled engine cylinder) can be produced in a mold made from the type of sand commonly used for cores. The sand is almost free flowing when packed around the pattern and it fills crevices well to reproduce details. After baking, the mold is strong enough to resist erosion and breakdown by the flowing metal. This method can be considered when complexity requires more than one parting line to produce a casting.

Shell mold casting—Molds are made by forming shells of resin-binded sand over a hot pattern and are suitable for small and some medium sized castings. The method provides: improved dimensional tolerances and surface finish, greater detail, and less draft than normally required by green sand process. Shell mold casting should be given particular consideration since it is a means for obtaining savings in machining and finishing of castings.

Permanent mold (gravity die) casting—Gray iron castings, within limits as to size, complexity and properties, can be produced in large numbers using mechanically operated permanent molds. This is a mechanized high production process. Such castings exhibit higher tensile strengths than gray iron castings poured in sand and shell molds because of the chilling effect of the metal mold.

Ceramic mold casting—Certain highly specialized castings requiring unusually fine finish, precise detail and close tolerances are produced in molds made of fired ceramics. The process is comparable to the plaster mold process used for nonferrous castings. Pattern equipment should be built to close dimensional tolerances and can be made of wood or metal. When the mold can be assembled in pieces, castings weighing up to 1500 lb and measuring several feet in major dimensions can be produced to relatively close tolerances.

Investment casting—A wax pattern is invested in a refractory material and is burned out when the refractory is fired. No consideration of draft or parting line is necessary since the pattern can be formed by assembling a number of parts. Investment castings can be produced with excellent finish and detail, and to close tolerances, but the process is generally limited to castings weighing 100 lb max.

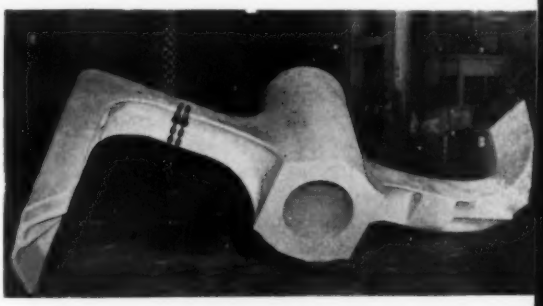
Centrifugal casting—This process is a means for producing a cavity in a casting without using a core. Pipe production by this process is well-known, but the method can be used for making other cylindrical castings such as engine cylinder liners and large process rolls. A second use: forcing metal into ceramic molds where the high metal surface tension and low permeability of the mold material may not allow complete filling of the mold by gravity alone.

Alloy Casting Institute

Heat treating fixture *of type HT alloy iron is used to suspend steering cams in carburizing furnace. Alloy withstands thermal shock and carburizing atmosphere.*

Alloy Casting Institute

Volute casing *used in nuclear power plant of N. S. Savannah is cast in CF-8 alloy. Casing weighs 3150 lb.*



General Steel Castings Corp.

Cast steel stern frame *for single screw cargo vessels. Rough weight, 79,250 lb; height, 25 ft, 6 in.; length, 22 ft; width, 4 ft, 6 in.*

TABLE 14—EFFECT OF MOLDING METHOD ON DIMENSIONAL CHARACTERISTIC OF CASTINGS

Process ➡	Green Sand—General	Green Sand—Optimum	Dry Sand	Shell	Permanent Mold	Investment
Tolerances Average ±	Gray irons, 3/64 in./ft; malleable irons, 1/32 in./ft.; steel, 1/16 in./ft	0.005 in./in. As little as 0.005 in. total on some casting dimensions	Similar to or better than green sand	0.005 in./in. As little as 0.003 in. total on some dimensions	0.015 in./in. for first inch. Add 0.001-0.002 for each added inch. May be cut to ±0.010 in. total in some castings	Min 0.004 in./in. Avg 0.005 in./in. on dimensions over 1 in.
Across Parting Line	Included in above values	Add 0.010 in. to above	—	Add 0.005-0.015 in. to above	Add 0.010-0.020 in. to above	Add 0.001 in./in. to above
Surface Finish, μin. rms	250-1000	100-250	Somewhat better than green sand	50-250	100-250	10-85
Section Thickness, in. Minimum	Gray irons, 1/8 in.; malleable irons, 1/8 in.; steel, 1/4-1/2 in.	Same as green sand	Same as green sand	Same as green sand	Gray iron, 3/16 in.	0.025-0.050 in. depending on surface area of the section
Maximum	No limit in floor or pit molds	—	—	—	20 in.	Normally 0.500 in.; may be more in some cases
Min Cored Hole Dia, in.	1/4 in.	3/16 in.	3/16-1/4 in.	1/8-1/4 in.	3/16-1/2 in.	0.020-0.050 in. dia.
Chilling Power[a]	1.0	1.0	0.2-1.0	0.2-1.0	200-500	1.0 (mold is heated)

[a] Relative to green sand.
Source: Adapted from American Foundrymen's Soc.

Designing ferrous castings

The rules of thumb outlined in this section may seem commonplace to some readers. We suspect, however, that many others will be encountering some (or all) of them for the first time. This section of the manual was written after replies were received to a questionnaire sent to ferrous foundries all over the country and ranging in size from large to small. Throughout the country foundrymen seem to have a universal complaint: designers are not following simple design rules which make the foundryman's job easier and reduce the casting costs of the purchaser. This situation should improve in the future as the foundryman and designer come to recognize each other's problems.

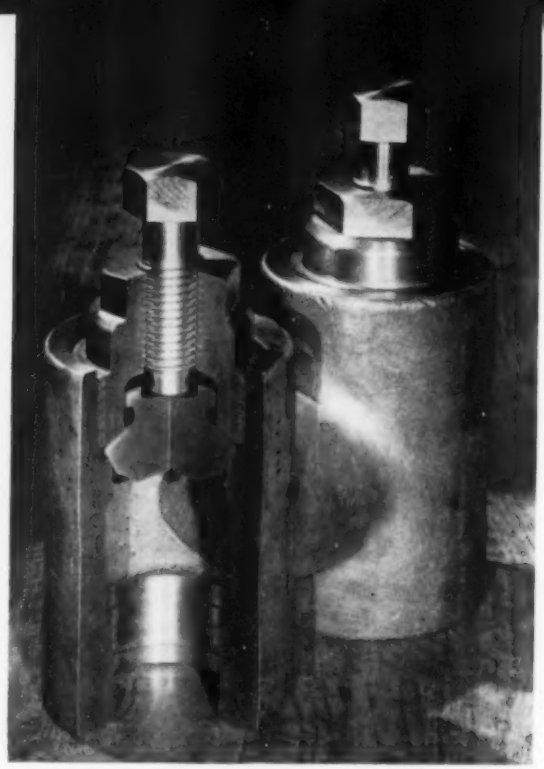
The designer holds the real key to lower casting cost. Proper recognition of factors that lead to good casting design *before* a design is frozen will reduce problems encountered after the patterns are made. Probably the one rule underlying all design considerations is that it is much more simple and less expensive to revise a drawing than it is to modify a pattern. Reducing the number of castings rejected because of inherent casting defects or eliminating unneeded weight in the form of risers or excessive thickness is good design practice. A foundry quotation is based not only on the weight of metal shipped but also on the weight returned to the scrapbin.

Here are nine simple design rules that apply to all ferrous castings:

1. Work closely with the foundryman.

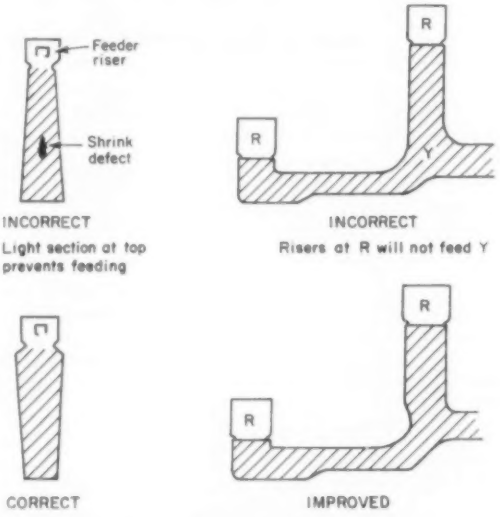
Early consultation between the designer and foundryman will eliminate obvious foundry problems and help in the solution of unexpected ones. Designing a casting which is a practical achievement, rather than a challenge to the foundryman's skill and ingenuity, is a serious matter. Foundrymen can answer many questions normally considered beyond the design engineer's purview: type of pattern needed, expected metal shrinkage, best molding method to consider, conditions necessary to make a dependable casting, machine finish, and dimensional limitations.

Since few engineers *or* foundrymen can follow all section changes from a blueprint, a three dimensional drawing or small model of the casting will permit a detailed study of such problems as: how will the metal enter the mold, how will solidification proceed, how must cores be designed and placed, what parts of the casting require risers to insure a sound casting, where may shrinkage or cracking be expected. Other questions that can be answered range from proper placement of gates and risers to probable cost and delivery.



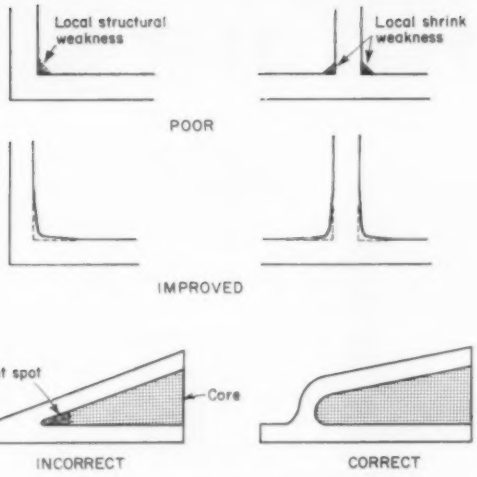
Alloy Casting Institute

***Header bodies** cast in CF-8 alloy resist extremely corrosive conditions encountered in refining crude oil at high temperatures and pressures.*



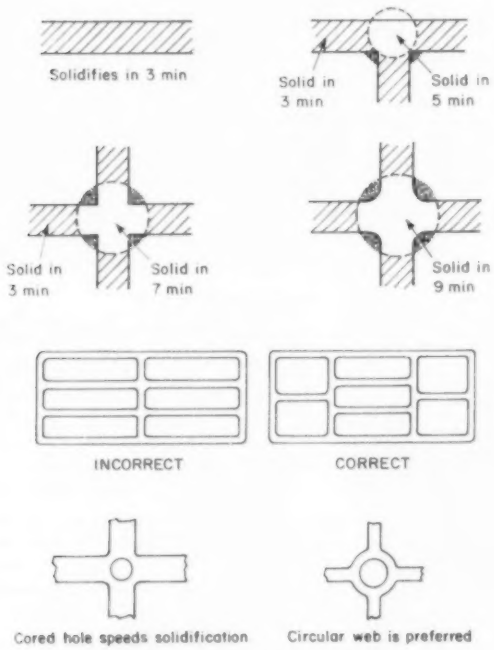
2. Design for casting soundness.

Since most ferrous casting alloys shrink during solidification, directional solidification and correct location of risers can be used to promote casting soundness. Whenever possible, thinner sections should be allowed to solidify first so that the heavier sections can act as a metal source during solidification. The heavier sections themselves can be fed by a riser. Attempting to feed a heavy section through a thinner one will always result in shrinkage porosity since the thin section solidifies first and chokes off the metal supply flowing to the heavier one.



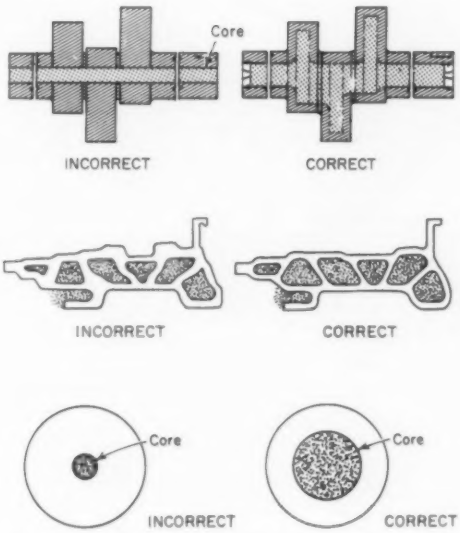
3. Avoid sharp angles and corners to eliminate hot spots.

To properly design adjoining sections, replace all sharp angles with radii. Eliminate sharp reentrant angles to eliminate heat concentration (hot spots).



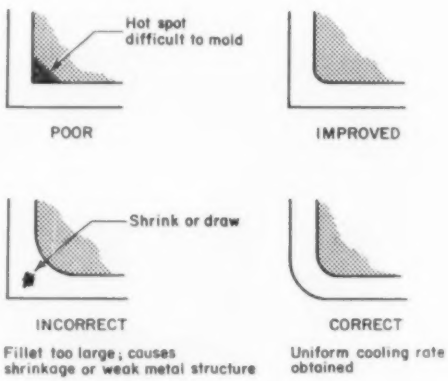
4. Bring the minimum number of sections together

The accompanying illustrations show very simply the degrading effect of joining many sections. The problem, when a design necessity, can be attacked by adequate coring or addition of webbing where the sections join.



5. Keep thickness as uniform as possible.

Joining sections of nonuniform thickness creates the problem of excessive porosity. It can be corrected by using proper coring technique or improving design to eliminate the thickness difference. The maximum range of thickness after proper blending should be no greater than 4-5:1. The i.d. of cylinders and bushings should exceed the wall thickness of the casting. When this is not possible, it is safer to cast the component as a solid and drill the required hole.

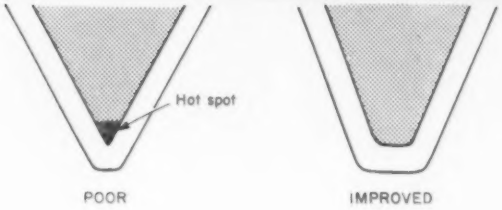


6. Use fillets.

Fillets have several functions. They help to: reduce stress concentrations in the casting; eliminate cracks and tears at re-entry angles; make corners more moldable; and eliminate hot spots.

7. Give angular forms an ample radius.

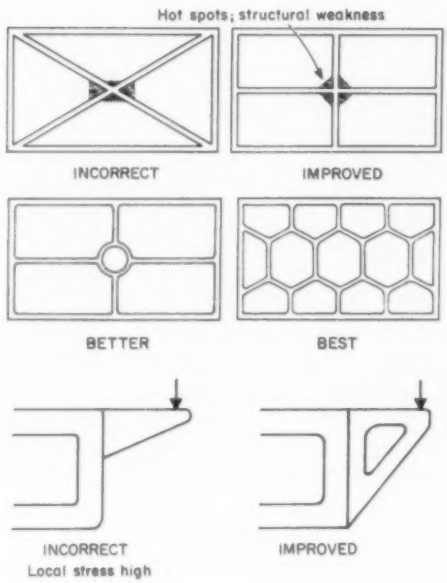
Allow a generous radius to eliminate hot spots in angular sections (such as V or Y sections).



8. Design ribs and brackets for maximum effectiveness.

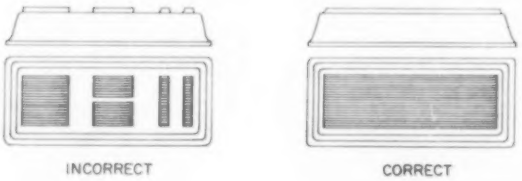
Ribs can increase stiffness and reduce weight. If too shallow in depth or too widely spaced, they are not effective. In designing the rib, reduce hot spot possibility by avoiding a local accumulation of metal. As pointed out in Rule 3, acute angles should be avoided. Therefore, the examples of poor and good rib design shown below are self-explanatory.

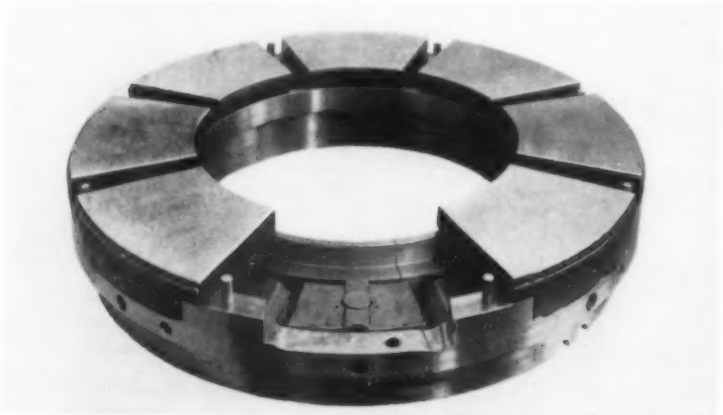
Brackets can be considered from two points of view. In the first, the bracket is cast separately and attached later to the main structure. This helps reduce manufacturing costs. When this approach cannot be used, make the length of contact with the main casting as ample as possible and provide the correct fillets to avoid hot spots and stress concentrations.



9. Do not use bosses, lugs and pads unless absolutely necessary.

Bosses, lugs and pads increase metal thickness and create hot spots. Except when casting gray or ductile iron, a lug should not be used when a similar surface can be obtained by milling or countersinking. When several lugs and bosses are located on one surface, they should be joined to facilitate machining.





Treadwell Engineering Co.

Kingsbury thrust bearing *for marine propeller shaft. Weight, 1580 lb; outside diameter, 47 in.*

Acknowledgment

The author would particularly like to thank Charles Walton, Gray Iron Founders' Society, and John Weaver, Waukesha Foundry, for reviewing the manuscript. Frederic Benz, Meehanite Metal Corp., supplied the information on casting design. Assistance of the following companies and societies is also gratefully acknowledged:

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Alten Foundry Div., Chromalloy Corp.
American Manganese Steel Div., American Brake Shoe Co.
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Cooper-Bessemer Corp.
Dayton Foundry
Eaton Mfg. Co.
Elyria Foundry Div., Chromalloy Corp.
Gray Iron Founders' Society
Hamilton Foundry
Lebanon Steel Foundry
Malleable Founders Society
Meehanite Metal Corp.
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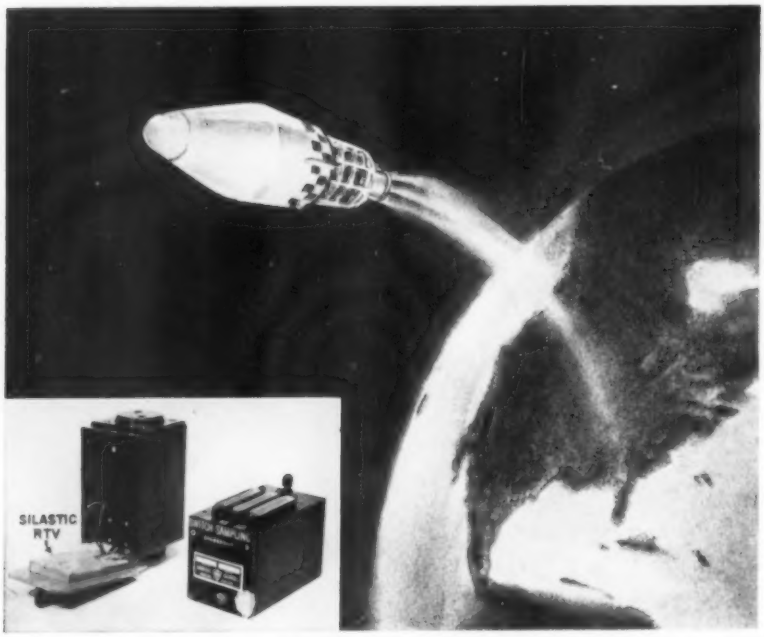

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FILE FACTS

Maximum Torque Values for Fasteners of Seven Materials[a]

Bolt Size	Low Carbon Steel[b]	304 Stainless Steel	Brass	Silicon Bronze	Aluminum 2024-T4	316 Stainless Steel	Monel
TORQUES IN IN-LB							
2-56	2.2	2.5	2.0	2.3	1.4	2.6	2.5
2-64	2.7	3.0	2.5	2.8	1.7	3.2	3.1
3-48	3.5	3.9	3.2	3.6	2.1	4.0	4.0
3-56	4.0	4.4	3.6	4.1	2.4	4.6	4.5
4-40	4.7	5.2	4.3	4.8	2.9	5.5	5.3
4-48	5.9	6.6	5.4	6.1	3.6	6.9	6.7
5-40	6.9	7.7	6.3	7.1	4.2	8.1	7.8
5-44	8.5	9.4	7.7	8.7	5.1	9.8	9.6
6-32	8.7	9.6	7.9	8.9	5.3	10.1	9.8
6-40	10.9	12.1	9.9	11.2	6.6	12.7	12.3
8-32	17.8	19.8	16.2	18.4	10.8	20.7	20.2
8-36	19.8	22.0	18.0	20.4	12.0	23.0	22.4
10-24	20.8	22.8	18.6	21.2	13.8	23.8	25.9
10-32	29.7	31.7	25.9	29.3	19.2	33.1	34.9
¼-20	65.0	75.2	61.5	68.8	45.6	78.8	85.3
¼-28	90.0	94.0	77.0	87.0	57.0	99.0	106.0
5/16-18	129	132	107	123	80	138	149
5/16-24	139	142	116	131	86	147	160
⅜-16	212	236	192	219	143	247	266
⅜-24	232	259	212	240	157	271	294
7/16-14	338	376	317	349	228	393	427
7/16-20	361	400	327	371	242	418	451
½-13	465	517	422	480	313	542	584
½-20	487	541	443	502	328	565	613
9/16-12	613	682	558	632	413	713	774
9/16-18	668	752	615	697	456	787	855
⅝-11	1000	1110	907	1030	715	1160	1330
⅝-18	1140	1244	1016	1154	798	1301	1482
¾-10	1259	1530	1249	1416	980	1582	1832
¾-16	1230	1490	1220	1382	958	1558	1790
⅞-9	1919	2328	1905	2140	1495	2430	2775
⅞-14	1911	2318	1895	2130	1490	2420	2755
1-8	2832	3440	2815	3185	2205	3595	4130
1-14	2562	3110	2545	2885	1995	3250	3730
TORQUES IN FT-LB							
1⅛-7	340	413	337	383	265	432	499
1⅛-12	322	390	318	361	251	408	470
1¼-7	432	523	428	485	336	546	627
1¼-12	396	480	394	447	308	504	575
1½-6	732	888	727	822	570	930	1064
1½-12	579	703	575	651	450	732	840

[a]Values in this table are intended as a guide only; the many variables make exact figures impossible.
[b]Grade C-1010 for sizes No. 10 and below; C-1018 for ¼ through ⅝ in.; alloy of C-1020 and C-1035 for larger sizes.

Courtesy Industrial Fasteners Institute

MATERIALS AT WORK

...AT A GLANCE

Strontium-90 power generators may someday be simple, reliable, long time sources of electrical energy. The proposed generators would consist of strontium titanate pellets tightly sealed within three layers of Hastelloy C. Heat produced by normal radioactive decay in about 1 lb of the compound could be converted directly into 5 w of continuous electrical energy by a series of thermoelectric elements surrounding the fuel capsules. The unit could operate without maintenance or refueling for several years.

Source: Martin Co., Nuclear Div., Baltimore 3.

Glass-reinforced Teflon piston rings were found to be superior to all other materials tested for use in jet engine starting systems. The manufacturer's selection of the material was based on its ability to retain strength and self-lubricating properties under operating temperatures of 545-595 F and pressures of 145 psi.

Source: Rogers Corp., Rogers, Conn.; piston rings fabricated by Janitrol Aircraft Div., Midland-Ross Corp.

A new four-cylinder engine using a stainless steel block is said to develop more power for its weight than any automobile engine now available. The engine, to be used initially in boats, and sports and racing cars, incorporates 40 lb of stainless to provide "rapid and uniform heat dissipation, good strength, low weight and corrosion resistance." The 175-hp engine weighs only 175 lb and occupies 125 cu in. of space.

Source: Committee of Stainless Steel Producers, American Iron & Steel Institute, 60 E. 42nd St., New York 17.

The nerve-wracking screech of chalk across a blackboard may be a thing of the past—thanks to a new vinyl chalkboard surfacing material. The colorful baked-on finish (blue, green, black) can be applied to any steel panel for use in offices and schools.

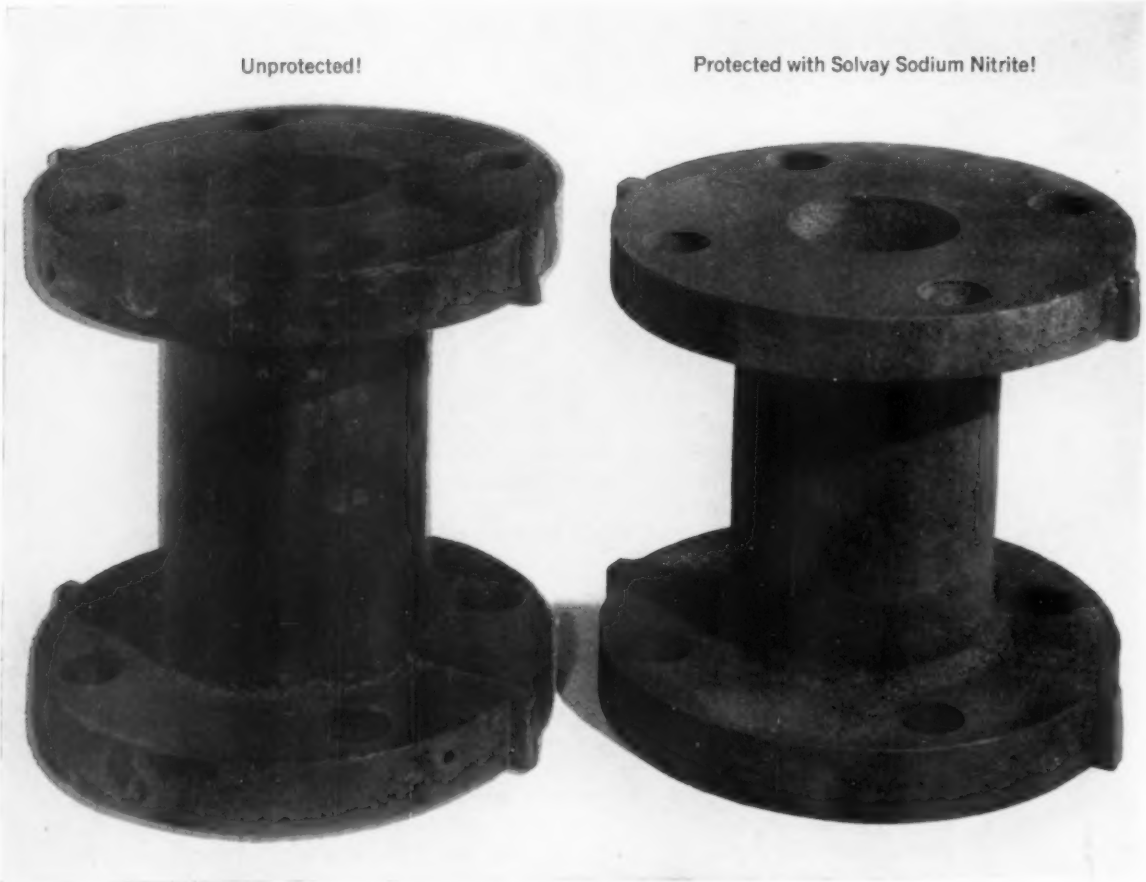
Source: John L. Armitage Co., 230 Park Ave., New York 17; boards manufactured by Virginia Metal Products, Inc.; vinyl resins produced by Union Carbide Plastics Co.

Beryllium parts for precision gyros are said to be "significantly superior to any other material." Here's why: they are as light as magnesium, have a modulus of elasticity 50% greater than that of steel, retain structural strength at temperatures above the melting temperatures of aluminum and magnesium, have the same electrical and thermal conductivity as aluminum, corrosion resistance, and a coefficient of thermal expansion almost equal to that of alloy steel. Some gyro parts made of beryllium include spin motors and rotor bearings.

Source: Sperry Gyroscope Co., Great Neck, L.I., N.Y.

The successful switch from steel to titanium rocket motor casings may add significantly to the range of the Air Force's Minuteman ICBM. The casing, which is used on the third-stage rocket motor, is made entirely of titanium and weighs about one-third less than conventional steel casings. The titanium casing withstood a static test firing so well that it will be cleaned, reloaded with solid propellant and used again.

Source: Aerojet-General Corp., 11711 S. Woodruff Ave., Downey, Calif.



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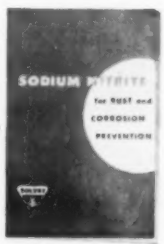
Guard metal parts in process against corrosion . . . easily, economically, effectively . . . with Solvay® Sodium Nitrite. Mix it in low concentration with water. Then apply as a spray or dip to protect parts in process and semi-finished parts in transport and storage.

Solvay Sodium Nitrite forms an invisible barrier of "tightly adhering" oxide film. It does not discolor metal nor have to be removed before further processing of the parts. Available in quick-dissolving, free-flowing flakes or granular form . . . in 400-lb fiber drums, 100-lb and 400-lb steel drums and 100-lb bags.

For full facts about this low-cost, proven way to prevent corrosion of ferrous metal and a free test sample, mail the coupon.



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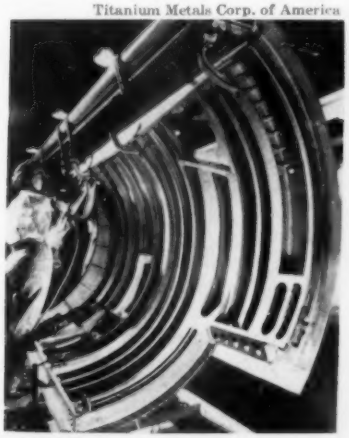
For more information, turn to Reader Service card, circle No. 322

Six Commercial Uses of Titanium

Greater supply and lower prices have helped spread the use of this "defense metal" to commercial applications needing its strength, lightness and corrosion resistance.

Titanium Metals Corp. of America



Access panel *of lightweight titanium is used in Douglas DC-8 engine pods for inspection and servicing. Each Ti-75A panel (102 in. by 76 in.) weighs 80 lb. The 1000 lb used throughout the DC-8 saves weight worth $525 for each coast-to-coast flight, United Airlines estimates.*

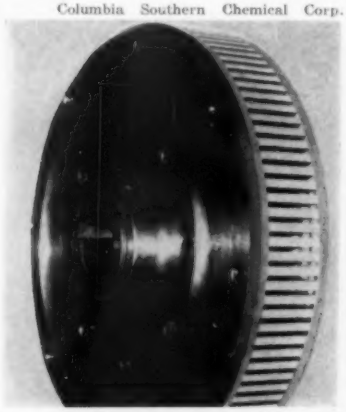
Titanium Metals Corp. of America

Rip stoppers *are high strength Ti-6Al-4V bands riveted at 18-in. intervals around the forward section of the DC-8 fuselage to guard against crack propagation and thus prevent sudden depressurization during flight.*

Pfaudler Co.

Experimental pump impellers *used in a pachuca tank for purifying a highly corrosive liquid (unspecified). The titanium pump (24 in. long with a 14-in. dia impeller) replaces a massive stainless steel unit. Both the cast and welded impellers shown proved satisfactory.*

Columbia Southern Chemical Corp.

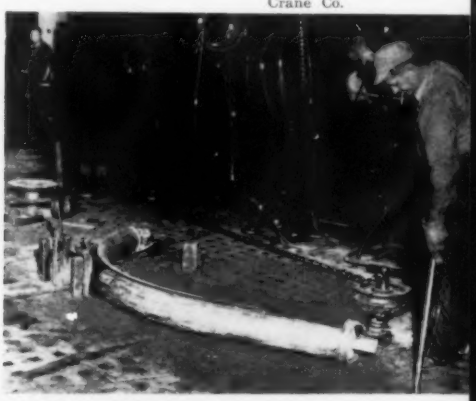


Spray wheel dryer, *turning at 10,000 rpm, centrifugally atomizes a calcium hypochlorite solution for drying. Components are machined from RS-130 and A-55 titanium alloys by essentially the same methods used to make the previous Hastelloy dryers. Corrosion has been greatly reduced and excessive bearing wear virtually eliminated.*

Crane Co.

Y valve *controls highly corrosive, hot slurries of nickel, cobalt and sulfuric acid. This 5-in. valve is forged of commercially pure titanium with ceramic seats and disks and is designed for 600 psi and 475 F. It is part of 28,000 lb of titanium equipment used in the nickel extraction plant built by Freeport Nickel Co. at Moa Bay, Cuba.*

Crane Co.



Titanium tubing *being bent at Crane Co.'s pipe shop before use in the Moa Bay installation. This 8-in. size is said to be the first fabricction of titanium pipe larger than 2 in. Republic Steel Corp. supplied the titanium used in the Moa Bay plant.*

Dacron Reinforcement Makes Stronger,

***Finished leg mold** at left is made with polyester reinforcement and has a clear, natural appearance. Old design at right, made with nylon stockinette reinforcement, has unattractive ribbed effect and is less comfortable. The pictures below show how the new mold is made.*

■ For the past two years the Veterans Administration's Prosthetics Center in New York City has been having great success with a nonwoven Dacron polyester fiber blanket reinforcement for its plastics prosthetic devices. In addition to providing greater strength than previous materials, the blanket (Troy Blanket Mills' Troytuf) makes the devices easier to prepare or modify, and better fitting.

In artificial limbs the socket area is the most critical section because it comes in contact with the skin. Prior to using the polyester material, designers and technicans were having difficulties with laminate fillers—sometimes in their preparation, but more often in making changes in the devices and in restoring original finish. Previously used reinforcements such as wood flour, cellulose fiber dipped in acetone, and a variety of acrylics lacked good structural strength. This weakness in some cases led to crazing and cracking. Also, one nylon stockinette filler that was used as an inner liner had ribbed edges which protruded and could not be completely removed. Since the edges were usually in the socket area and in contact with the skin, they often pro-

HOW A BELOW-THE-KNEE LEG MOLD IS MADE

1 Dacron blanket reinforcement is trimmed to size. *After cutting, the nonwoven polyester fiber material is stitched to form a sleeve.*

2 Sleeve is placed over leg mold. *Pliability of polyester blanket allows it to conform to every contour. Bottom of tightly-drawn blanket is later bound with string to prevent material from springing back.*

3 Plastic film is sealed over mold *to act as receptacle and outer mold for liquid resin. Film material is polyvinyl alcohol.*

Better Fitting Prosthetic Devices

duced objectionable irritation.

After considerable experimentation the Center found that a polyester fiber blanket reinforcement used in conjunction with a polyester resin provides superior strength and does not crack or craze. In addition, the material can easily be modified to a new shape and sanded or smoothed to its original finish. Unlike nylon stockinette, no rough edges protrude after changes are made in the device.

Previously, when modifications had to be made in a device the filler had to be smeared on the area to be built up. This operation was complex and messy. Polyester materials, however, lend themselves readily to patching procedures. After roughing the surface of the area to be changed, a piece of polyester blanket is dipped in the laminate resin and applied to the area. It adheres immediately.

5 ***Resin is squeezed down over polyester blanket*** *until it is completely saturated. If resin were allowed to spread at its own speed it would set before lamination was completed.*

4 ***Liquid resin is poured into mold*** *to start the lamination process.*

6 ***Stringing the resin*** *helps distribute it evenly and removes air pockets. When using an air-curing resin this is the last production step before removing device from mold. Otherwise, an oven curing step is required.*

MATERIALS AT WORK

New Ceramic Gyro Has Best Accuracy

Use of ceramics has made possible what is described as "the greatest improvement in production gyroscopes in a decade."

The new gyro, which is said to represent a ten-fold improvement in gyro accuracy, was made possible by the development of 1) a new ceramic material as hard as sapphire that can be diamond-honed into the tiny and ultra precise shapes required for critical gyro parts; and 2) a miniature ceramic self-generating gas bearing.

Causes of drift reduced

According to Minneapolis-Honeywell Regulator Co., the combination of ceramic parts and gas bearings has sharply reduced the major causes of gyro drift and inaccuracies, and has resulted in a gyro with a theoretical life span approaching infinity. Thus far, Minneapolis-Honeywell is unwilling to release details on the nature of the new ceramic.

Up to now, gyros have used ball bearings that are relatively unstable and subject to wear. The ceramic bearings in the new gyro are lubricated by a film of gas only 0.0000025 in. thick. The film is virtually friction-free and reduces vibration by a ratio of 30 to 1.

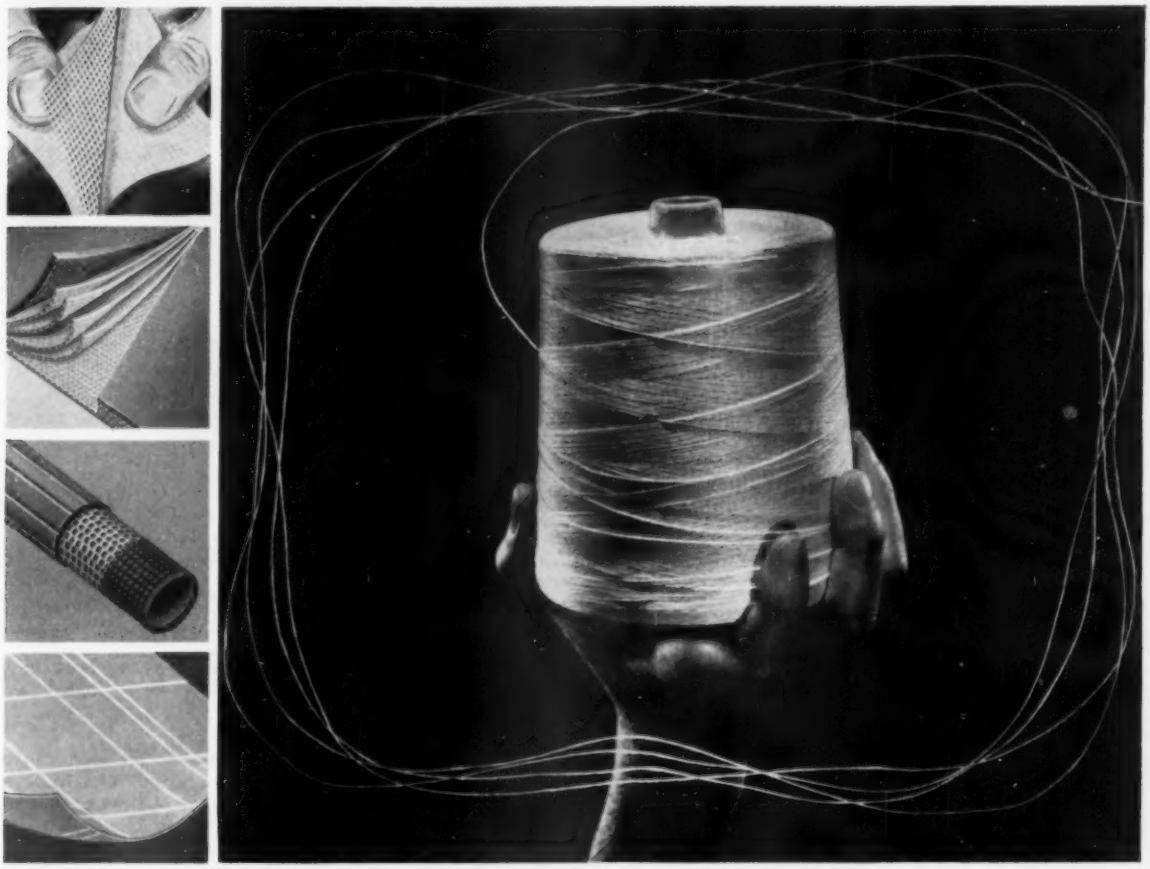
Although the principle of gas bearings is not new, previous models without ceramics have been severely limited in size due to bearing wear caused by frequent stopping and starting. The new gyro, only 2.817 in. long and 2.0 in. in dia, weighs only ½ lb and has thus far successfully withstood many thousands of starts and stops without detectable wear.

In addition to eliminating nearly all drift caused by worn ball bearings, the new gyro also uses ceramics to reduce drift caused by instability of other parts, such as the spin motor and gimbal constructions. In stability tests, the new ceramic parts were found to retain original dimensions within 0.000002 in. after being subjected to temperature variations ranging from —85 F to 1500 F.

Ceramic as hard as sapphire

The gyro parts are rough cast in powdered form. In this half-fired

An example of Avisco Rayons in Industry



Here's how industry adds muscle to reinforced paper, plastics and rubber.

There are many uses for laminated paper, plastics and rubber which require the addition of a high tensile reinforcement. One of the best is also one of the cheapest: Rayflex high strength filament. You'd pay 22% to 100% more for other fibers with comparable strength, impact and flex life.

Rayflex is the foundation for hose and belting, the basis of packaging tapes, the ideal filament for scrim fabrics that give paper, plastic and foil the economical extra strength they need in laminated constructions.

Avisco rayon can be engineered to meet specific reinforcing needs. Fabricators and users of products that require reinforcement have found that it pays to consult us. We'll be glad to study your problems.

QUICK REPLY COUPON 2-4

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American Viscose Corporation
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Please contact me about Avisco Fibers for reinforcing use in _____

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AVISCO® RAYON

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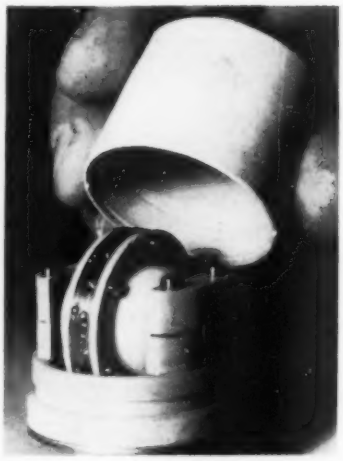
For more information, turn to Reader Service Card, circle No. 330

MATERIALS AT WORK



***Tiny precision gyro** about to be encased in its ceramic gimbal.*

"green" state, the material can be easily worked. After final firing at 3200 F, however, the material becomes as hard as sapphire.

Since this hardness is greater than that of ordinary grinding wheel materials, the ceramic parts have to be finish ground with diamond compounds. However, extreme accuracy and excellent surface finish are possible. In fact, Minneapolis-Honeywell says that tolerances on some parts are held to less than ±0.000003 in.

According to Minneapolis-Honey-

***Ceramic components** of new gyroscope include: front row, from left to right—gyro end bell, spin motor and shaft, balance wheel (only non-ceramic component) and second end bell; back row—ceramic gimbal and assembled spin motor mounted in a portion of the gimbal.*

Naugatuck PARACRIL OZO

Now an oil-resistant rubber with **color**

...*any* color...*any* shade...for almost any rubber product

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And now *all the color you can use* is yours in a synthetic rubber compound so tough, so oil, chemical, weather, and ozone resistant, it actually outperforms other rubbers. No longer need you think in terms of gray, brown, and black for any weather-resistant rubber.

Paracril® *OZO*—a unique blend of acrylonitrile-butadiene rubber and vinyl developed in the Naugatuck Chemical laboratories of U. S. Rubber—is already demonstrating its product-improvement power in a wide range of highly successful applications. And it's ready and waiting to do the same for *your* product.

Take a look at Paracril OZO. Full information is immediately available from your nearest Naugatuck Representative or the address below.

Naugatuck Chemical

Division of United States Rubber Company 1041P Elm Street Naugatuck, Connecticut

Rubber Chemicals · Synthetic Rubber · Plastics · Agricultural Chemicals · Reclaimed Rubber · Latices · CANADA: Naugatuck Chemicals Division, Dominion Rubber Co., Ltd., Elmira, Ontario · CABLE: Rubexport, N.Y.

For more information, turn to Reader Service card, circle No. 412

MATERIALS AT WORK

well, the new ceramic gyros, which are designed for use in missile and space vehicle guidance systems, are virtually impervious to the acceleration, vibration, pressure and temperature changes encountered in these applications.

'Impossible' Part Made by Combination Casting

By combining investment and plaster mold casting techniques, Atlantic Casting & Engineering Corp. has been able to produce a precision, one-piece component that previously was impossible to produce in one piece and required costly fabrication and machining operations.

Two parts used previously

The component, a one-piece cross-guide coupler (see accompanying photo), was previously made from two individual H-plane bends that required 1) machining of coupling slots in the wall of one bend, 2) cutting away a wall section of the other bend, and 3) joining both by brazing.

In addition to the time required for these operations, there were these other disadvantages: the brazed joint caused interior irregularities which often could not be reached for smoothing; and an imperfect relationship sometimes existed between the two wave guides.

Part is now a single casting

The new coupler is cast in one piece, complete with coupling slots, by means of a single one-piece core. The core, a rectangular translucent wax section (shown at right of photo) containing two cross-shaped holes, is positioned in the coring mold so that the cross-shaped holes connect the two major elements that form cores for the two H-plane bend interiors. Core slurry flows through these openings in such a way that after the slurry sets and the coring is removed, the form of the entire coupling is reproduced in a single piece. The wax section is then vaporized and the molten metal poured.

According to Atlantic, this method produces a perfectly regular, jointless interior. Cost per part is less because machining, jigging and brazing are eliminated. And performance

HAYNES ALLOYS

RESEARCH REPORTS

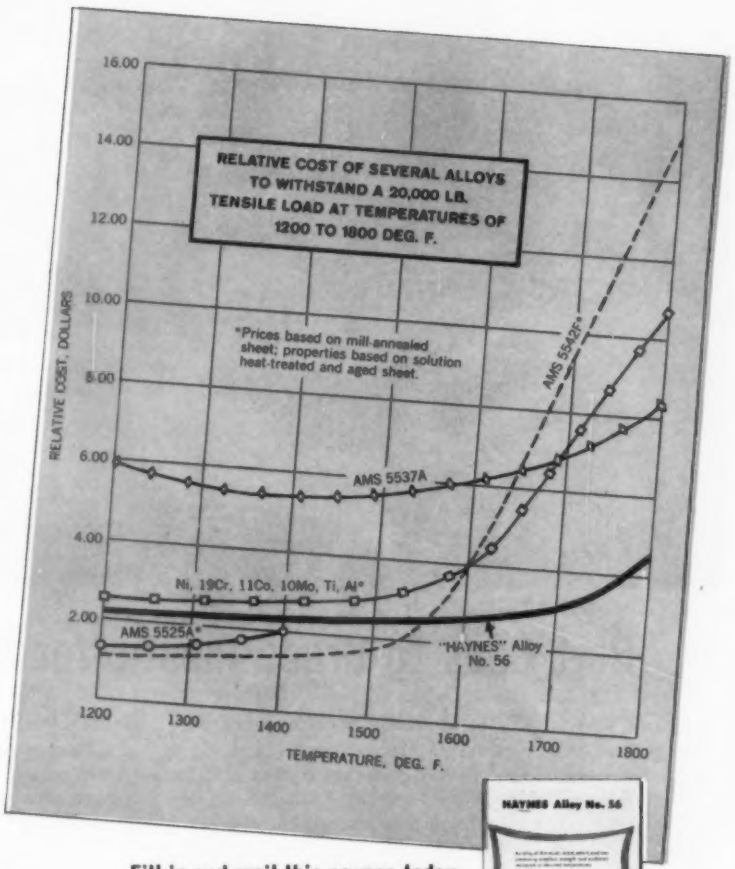
New High-Temperature Alloy Improves Cost-To-Strength Ratio

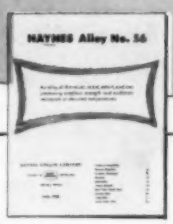
Excellent strength and oxidation resistance in the 1200 to 2000 deg. F. range are among the features of HAYNES Alloy No. 56—a new high-temperature alloy developed by Haynes Stellite Company.

A sampling of its cost advantages at a given tensile load, compared with other high-temperature alloys in the graph at the right, is well worth your study.

Alloy No. 56 can be readily hot-worked and formed. It is easy to heat treat. It comes in the form of sheet, plate, bar, wire, and coated welding electrodes, and can be furnished as sand-, investment-, and resin shell-mold castings. The coupon below will bring you a wealth of technical data.

The new iron-base alloy contains nickel, cobalt, chromium, and molybdenum. It has high strength at temperatures up to 1500 deg. F and maintains useful strength at temperatures as high as 2000 deg. F.





HAYNES ALLOYS

HAYNES STELLITE COMPANY

Division of Union Carbide Corporation

Kokomo, Indiana

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Fill in and mail this coupon today

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270 Park Avenue, New York 17, N.Y.

Please mail me the free, 16-page properties-data booklet on the new HAYNES Alloy No. 56.

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For more information, turn to Reader Service card, circle No. 381

Part Goes to Grace Plastic for Greater Durability

Automatic Milk Service, Inc. improved the performance of its coin operated milk vending machines through a change in design and material for one key part. The part is a chute through which milk cartons are dispensed. Produced the new way, it rarely requires repairs or maintenance.

The chute is subjected to rugged treatment every time the machine is operated (a carton of milk is released from above and hits the chute with considerable impact), and every time the machine is filled (the serviceman uses the chute as a platform to hold his milk case). Many different materials were tested for the part. Grace's high density polyethylene was chosen as the material that could withstand such abuse over a long period. The chute was redesigned for efficient vacuum forming with Grex sheet by Highland Products, Inc.

Chutes made from this Grace plastic stand up so well they rarely require attention. Even in cold weather, when other plastic materials lose their strength, these Grex chutes will not crack or break on impact.

For the vending machine company the use of Grex means longer chute life and lower maintenance costs. Perhaps you can reduce costs, too, by taking advantage of Grex for your products. The best way to find out is by calling in the experts. Grace has the production, technical and marketing facilities to help put your product in the Grex profit parade. Everyone says we're easy to do business with.

Grex is the trademark for W. R. Grace & Co.'s Polyolefins.

W.R. GRACE & CO.
POLYMER CHEMICALS DIVISION
CLIFTON, NEW JERSEY

For more information, turn to Reader Service card, circle No. 376

Large part designed with deep draws successfully vacuum formed from Grex sheet.

The experience of Highland Products, Inc. in redesigning and forming the chute for milk dispensing machines may give you some ideas on how to take maximum advantage of Grex for your *own* projects.

Simplification in design was the first step in production of the part. Originally it was a complicated assembly of nearly twenty pieces. The new design by Highland calls for only two large vacuum formed Grex pieces plus three flat Grex strips as stiffening members.

Deep draw required. In the interests of production efficiency and part performance, Highland's design calls for deep draws, straight walls and sharp corners. Such design requirements are difficult to satisfy in thermoforming many types of plastic sheet. The fact that satisfactory parts are being produced may be attributed to the thermoforming characteristics of high density polyethylene.

Slow cooling an advantage. High density polyethylene remains workable for a relatively long period. In this case, the Grex sheet is workable for 60 to 90 seconds after drawdown—sufficient time to obtain necessary detail on the sides of the pieces.

Want to know more about what can be accomplished by vacuum forming of Grex sheet? If you have an application in mind, give Grace Technical Service the opportunity to help you. We may not know all the answers, but we do have experience with high density polyethylene on our side—and are learning more every day.

Technical Service Department
W. R. Grace & Co., Clifton, New Jersey

***Intricate coupling** (left) is cast in one piece using wax pattern (right).*

of the finished part is superior because the two channels are positioned with greater accuracy.

Styrene-Acrylonitrile Replaces Metal Blade

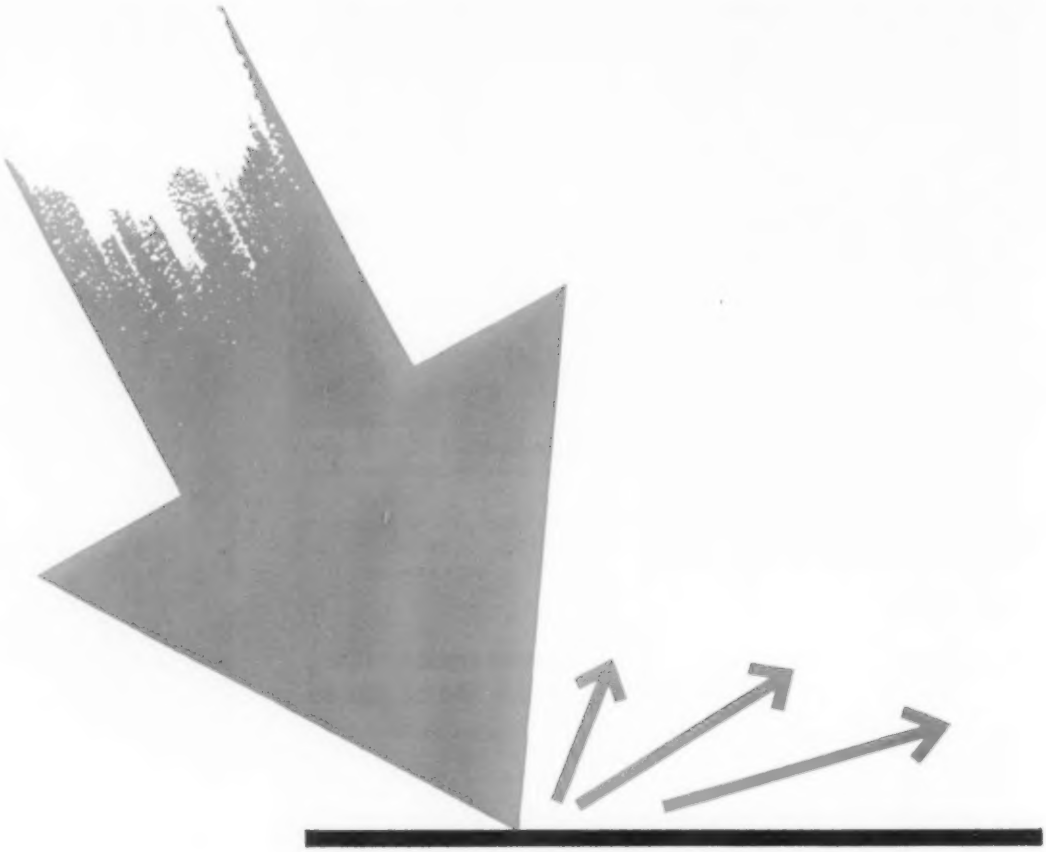
Molded styrene-acrylonitrile copolymer has replaced metal stampings for fan blades used in Philco Corp.'s room air conditioners (see accompanying photo).

According to Philco, there were several reasons for the switch: 1) reduced fan noise, 2) improved balance, 3) elimination of corrosion, and 4) reduced costs.

Two other plastics were tested. Rubber-modified materials were discounted because they did not have sufficient tensile strength to avoid creep under the centrifugal forces caused by fan rotation. Polystyrene blades had insufficient resistance to deflection (they deflected 5/8 in., compared to 3/16 in. for styrene-acrylonitrile).

According to Dow Chemical Co., producers of the styrene-acrylonitrile copolymer, the material is ideally suited to this application because it provides good tensile strength, good chemical resistance, and ease of fabrication.

***Plastic fan blade** is more efficient, less expensive than metal.*



Metallurgical Phenomena... and the metals to cope with them.

These are the stock-in-trade of the Lukens Application Engineer—whether the problem be one of abrasive impact (symbolized above) or corrosion or pressure or structural stress or high and low temperature. Investigation of the best steels for "problem" applications has been carried on for years by the Lukens Application Research team. We would welcome the opportunity to contribute the results of this research to your own design knowledge. Please contact us in your early design stages. Call collect: Joe Proctor, Manager of Application Engineering, Extension 422, Lukens Steel Company, Coatesville, Pennsylvania.

HELPING INDUSTRY CHOOSE STEELS THAT FIT THE JOB

For more information, turn to Reader Service card, circle No. 397

ENGINEERING & DESIGN

(cont'd from p 122)

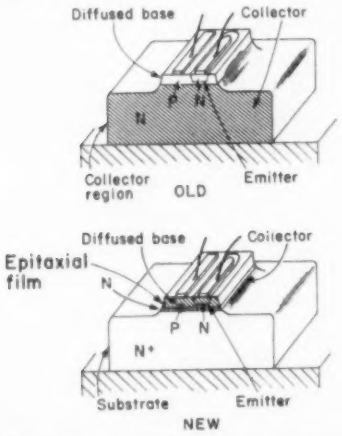
Film Technique for Transistors

Major reductions in switching times and collector resistances of silicon and germanium-base transistors have been realized at Bell Telephone Laboratories by using epitaxially grown films, i.e., films grown as an extension of a single crystal substrate.

According to the developer, diffused base transistors require a relatively high resistivity collector region in order to attain low capacitance and high voltage breakdown. To date, the collector region has been much thicker than required electrically in order to afford ease in handling. However, the excess thickness increases collector resistance and, through carrier storage, switching time.

Thickness of collector region reduced by new technique

Ideally, the thickness of the collector region should be 0.1 mil. Semiconductor wafers prepared by conventional methods become extremely difficult, if not impossible, to handle as they approach this desired thinness.



***Thickness** of collector region in a conventional diffused base transistor (top) has been reduced considerably in new epitaxial diffused transistor construction (bottom).*

But Bell Telephone Laboratories says the problem of a thinner collector region can be solved by using epitaxial film techniques. Lightly doped epitaxial films are grown on and supported by a low resistivity substrate giving the desired combination of electrical properties and mechanical strength.

Tests show that switching time in a typical silicon transistor circuit has been reduced from 200 to 20 millimicroseconds by using the epitaxial film technique. In addition, collector series resistance of the epitaxial transistors was reduced by a factor of more than 10 and was comparable to that of conventional devices 15 times larger.

Bell Telephone Laboratories, located at 463 West St., New York 14, says use of epitaxial material in diffused base transistors simplifies the design and understanding of transistor devices and brings them closer to ideal forms.

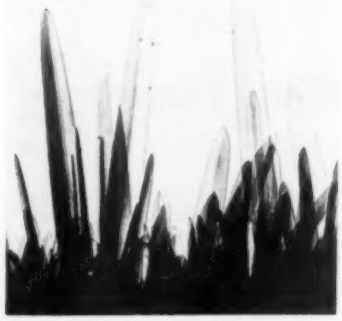
Hydrogen Blamed for Rusting of Iron

What causes iron to rust?

Dr. Earl A. Gulbransen and T. P. Copan, scientists at Westinghouse Research Laboratories in Pittsburgh, suggest that tiny hydrogen particles from water vapors penetrate iron and enlarge the sites at which oxygen normally combines with the metal. This spreads the reaction throughout the surface of the iron, causing it to rust destructively.

Theory may supplant standard explanation for iron corrosion

Until now, a standard explanation for iron corrosion has been that it is an electrochemical reaction, i.e., tiny local areas on the surface of the metal are assumed to act as plus and minus electrical terminals under the influence of an invisible liquid film of water, generating minute electrical currents that corrode



Destructive crystals *of iron oxide erupt on the surface of iron when the metal is exposed to an atmosphere of water vapor.*

the iron. The new theory suggests that something more fundamental takes place in iron, even though an electrochemical reaction may also be present.

Complex rusting of iron reduced to simple process

Gulbransen and Copan arrived at their finding by conducting a series of experiments in which the complex rusting of iron was reduced to its simplest atomic processes, i.e., conditions required for electrochemical reactions were eliminated in the experiments.

They took pure iron wires about as thick as a fine sewing thread and reacted them with oxygen and water vapor at 835 F under closely controlled conditions. The iron wires were then studied under an electron microscope capable of magnifying objects up to 300,000 times. Here's what the microscope showed:

1. In a dry oxygen atmosphere the iron forms a protective oxide coating from which grow billions of tiny oxide whiskers less than one millionth of an inch in diameter and 30 millionths of an inch high. Each whisker grows from a single, specific growth site on the metal's surface.

2. But in an atmosphere of water vapor the surface of the iron erupts into thin, blade-shaped platelets of iron oxide (see accompanying photo), which reach a density of nearly one billion per square inch of surface area. As the blades grow in size,

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they spread across the surface of the iron, causing it to corrode destructively.

The platelets are about one millionth of an inch thick, 30 millionths of an inch wide and 300 millionths of an inch high. The amount of rust the platelets represent is 250 times that which forms when the water vapor, and the hydrogen ions it releases, are absent from the reaction.

Small amount of water vapor starts rusting of iron

The experiments show that less than one part of water vapor in 200 parts of the dry oxygen atmosphere will cause the blade-shaped crystals to form. This corresponds to a relative humidity of about 3% at room temperature.

In order to reduce iron corrosion, estimated to waste some $6 to $7 billion per year in this country, Gulbransen says, "Hydrogen must be prevented from entering the metal, and the growth of the localized reaction sites must be inhibited by the addition of suitable alloying elements to the iron."

Stainless studied earlier

In an earlier work on stress-corrosion cracking of stainless steel (see M/DE, Jan '58, p 150), Gulbransen found that minute crystals, described as submicroscopic platelets of chromium oxide, tend to grow from the surface of stainless steels when the metals are stressed and exposed to corroding atmospheres.

New Property Data on Heat Resistant Epoxy

The accompanying table (p 166) gives more property data on a new high temperature epoxy resin called VC-8359. The data were obtained from qualification tests performed by the Forest Products Laboratory as specified under military specification MIL-R-9300A.

The epoxy resin, developed by Brunswick Corp. (formerly Brunswick-Balke-Collender Co.), Marion, Va., was described in the April issue of this magazine (p 17). A B-staged prepreg containing VC-8359 and either glass cloth or roving is commercially available from

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PROPERTIES OF VC-8359 LAMINATES[a]

	MIL-R-9300-A Requirements	VC-8359
ORIGINAL MECHANICAL PROPERTIES		
Flex Str, 1000 psi	70	76
Flex Mod of Elast, 10^6 psi	3.2	3.47
Ult Ten Str, 1000 psi	47	59
Ult Compr Str (edgewise), 1000 psi	50	62
AFTER AGING IN WATER[b]		
Flex Str, 1000 psi	65	72
Flex Mod of Elast, 10^6 psi	3.2	3.40
Ult Ten Str, 1000 psi	45	58
Ult Compr Str (edgewise), 1000 psi	45	51
AFTER OUTDOOR WEATHERING[c]		
Flex Str, 1000 psi	65	76
Flex Mod of Elast, 10^6 psi	3.2	3.66
AFTER AGING IN MIL-O-5606 OIL[d]		
Ult Flex Str, 1000 psi	65	77
Weight Chg, %	±2.0 max	+0.04
Thickness Chg, %	±0.2 max	+0.05
AFTER AGING IN MIL-F-5566 FLUID[d]		
Ult Flex Str, 1000 psi	65	80
Weight Chg, %	±2.0 max	−0.07
Thickness Chg, %	±0.1 max	−0.05
AFTER AGING IN MIL-H-3136 FLUID[d]		
Ult Flex Str, 1000 psi	65	76
Weight Chg, %	±2.0 max	−0.01
Thickness Chg, %	±0.2 max	−0.05

[a]Specimens: 12-ply, ⅛ in. thick, 181 cloth, Volan A finish, 33% resin. Test methods as specified in Fed Spec LP-406-b.
[b]Aged 30 days at room temperature, then tested wet.
[c]Aged three months.
[d]Specimens aged 7 days at room temperature in accordance with Fed Spec LP-406-b, Method 7011.

U. S. Polymeric Chemicals, Inc., 700 Dyer Rd., Santa Ana, Calif.

Preparation of laminates

As reported in the April issue, wettability and viscosity of the new epoxy resin are such that several plies of cloth can be laid down and impregnated at once, as opposed to the standard procedure of impreg-

nating one ply at a time.

The developer recommends the following procedure for preparing and curing VC-8359 laminates:

1. Weight of catalyzed resin should equal weight of the cloth, and the cloth should be 181 style with Volan-A finish. Layup should be parallel to the warp.

2. After layup, the laminate should be bagged and placed in an oven at 250 F. Flat laminates should be prepared on a polyester film that has been taped to an aluminum platen.

3. After heating for 20 min, the laminate should be removed from the oven, squeezed to the correct thickness, and returned for 3 hr at 250 F. Polyester film and bag material should be removed from the laminate immediately after it is removed from the oven.

Mechanical Properties of Spun Metal Parts

In spite of the relatively wide use of spinning as a forming method there is little information available on the mechanical properties of spun metal parts. But a recent report on the mechanical properties of spun metal parts by four University of Michigan investigators should help fill in some of the gaps.

The investigators performed a series of tensile tests on mechanically and hand spun cartridge brass (70% copper–30% zinc) and aluminum alloy 1100.

Spinning analogous to cold rolling

Data from their tests showed that tensile and yield strengths of mechanically and hand spun parts increased, and elongation decreased, with increasing reductions in thickness.

Other data derived from the tests showed the following:

1. Tensile properties of mechanically spun parts are similar to properties produced by cold rolling to an equivalent reduction. Thus, tensile properties of mechanically spun parts can be estimated from

Based on a paper written by S. Floreen, D. V. Ragone, E. E. Hucke and W. D. Carleton of the University of Michigan Research Inst., Ann Arbor, Mich.

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How zinc-coated steel cut 5 steps from automotive lamp housing fabrication.

When automotive head and tail lamp housings were drawn from cold rolled sheet steel and then zinc-plated or painted, as many as five or six handling and cleaning steps were required to make them corrosion-resistant.

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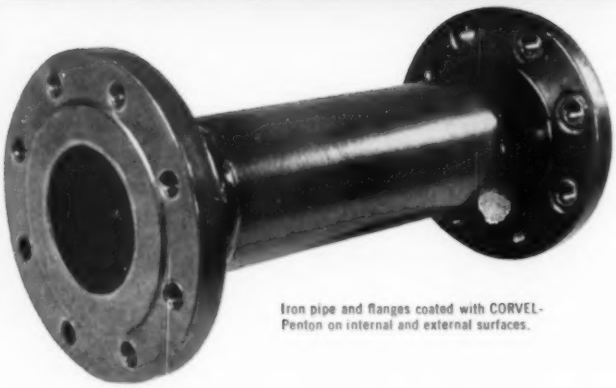
(PHOTO COURTESY GOULDS PUMPS, INC.)

Flowmeter coated with CORVEL-Penton provides high-order corrosion resistance for use in a wide variety of chemical atmospheres that attack metals. ▶
(PHOTO COURTESY BROOKS ROTAMETER CO.)



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‡The basic fluidized bed process was developed and patented in Germany. Polymer's WHIRLCLAD coating system which encompasses the fluidized bed technique is protected by various apparatus and process patents in the United States and foreign countries and numerous applications are pending. Exclusive patents and licensing rights in the United States and Canada are owned by a subsidiary of The Polymer Corporation.

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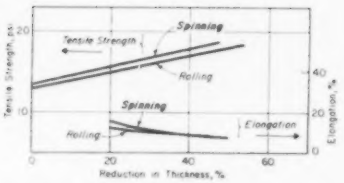

Properties of aluminum: *mechanical spinning vs cold rolling.*

cold rolled properties.

2. Tensile properties of mechanically spun parts depend on the relative change in die dimensions and not on the original thickness of the unspun blank.

3. Hand spun parts have a smaller increase in tensile properties than mechanically spun parts. Hand spun parts also have a much greater scatter in tensile values.

4. There is a progressive decrease in hardness from the spun surface to the back surface of mechanically spun parts, as indicated by micro-

PROPERTIES OF SPUN ALUMINUM[a]

Cone Angle, deg →	63	85	108
MECHANICALLY SPUN			
Ten Str, 1000 psi	19	18	16
Yld Str (0.2% offset), 1000 psi	17	16	15
Elong (in 1 in.), %	9	10	12
Hardness (Brinell)	30	28	27
HAND SPUN[b]			
Ten Str, 1000 psi	16	17	15
Yld Str (0.2% offset), 1000 psi	14	17	14
Elong (in 1 in.), %	15	16	14
Hardness (Brinell)	29	28	27

[a]Values given for radial test specimens spun from an 0.081-in. thick blank.
[b]Values give are an average of four test specimens.

PROPERTIES OF SPUN BRASS[a]

Cone Angle, deg →	63	85	108
MECHANICALLY SPUN			
Ten Str, 1000 psi	80	78	70
Yld Str (0.2% offset), 1000 psi	75	63	66
Elong (in 1 in.), %	7	10	9
Hardness (Rockwell)	B87	B85	B80
HAND SPUN[b]			
Ten Str, 1000 psi	72	70	63
Yld Str (0.2% offset), 1000 psi	57	66	59
Elong (in 1 in.), %	8	14	15
Hardness (Rockwell)	76	72	69

[a]Values given for radial test specimens.
[b]Values given are an average of four test specimens.

***Schematic view** showing various cone angles of spun metal parts.*

hardness measurements. However, hardness of mechanically spun parts is generally higher than that of hand spun parts.

5. Mechanical spinning is the best method to use if overall uniformity of strength is desired in a spun part.

6. There is a relatively constant hardness through the cross section of hand spun parts. Accordingly, hand spinning would seem to be the best method to use if a spun part were to be age hardened.

Testing, spinning procedures

The tensile specimens used in the tests were taken in radial and tangential directions from spun cones. No differences in tensile properties were observed in the two directions.

Different reductions were obtained by varying the apex angles of the cones. The angles were 63, 85 and 108 deg. In all cases the final diameters of the cones were approximately constant and equal to the original diameter of the unspun blank.

Vanadium Resists Salt Water, Acids

Chemical and galvanic corrosion studies by D. Schlain, C. B. Kenahan and W. L. Acherman of the Dept. of the Interior, Div. of Mineral Technology, College Park, Md. show that ductile vanadium has good resistance to salt water, 60% sulfuric acid and 20% hydrochloric acid at 95 F.

The tests further show that vanadium, although it has good resistance to 3% nitric acid, corrodes very rapidly in 17% nitric acid. Absence of air had little or no effect on the corrosion of vanadium in these environments.

The three men, whose work is described in the Feb '60 issue of *Corrosion*, say that vanadium is less corrosion resistant in salt water than stainless steel and copper, but is more resistant than aluminum, magnesium and SAE 4130 steel.

They say that vanadium, when

coupled with these metals, behaves as a sacrificial metal for copper, but is protected by aluminum, SAE 4130 steel and magnesium. Neither vanadium nor stainless steel is affected by contact with each other, according to the researchers.

Ceramics Promising for Space Flight Use

A new approach to use of ceramics in space flight in which the material modifies itself to meet environmental conditions was described by D. M. Scruggs of Bendix Aircraft Corp. at a recent meeting of the American Ceramic Society.

Scruggs reported that iron, nickel and chromium oxide coatings on a magnesia base ablate at temperatures as high as 4500 F and at speeds as high as mach 1.8 to produce a thin layer of molten magnesium oxide which protects the magnesia base.

He says this approach can be used to meet certain materials requirements for rockets, atomic reactors, ramjets and other applications.

Welding Method Joins Coated Steel

Magnetic force welding can be used to attach brackets, braces and other parts to steel that has been coated on one side with paint or acrylic lacquer.

It can also be used to fabricate steel that has been laminated on one side with wood veneer, according to Precision Welder and Flexopress Corp., 3518 Ibsen Ave., Cincinnati 9, Ohio.

The technique, described in the Jan '60 issue of this magazine (p 119), is said to produce strong welds that are invisible on the coated side of the metal.

The magnetic force welder used in the technique is usually a conventional spot welder that has been redesigned to accommodate electromagnets for the application of pressure. In most applications, the welding time is short, varying from one-half to a few cycles.

Atmosphere generator tube to resist temperatures of 1800°-2300°F is installed by Lindberg Engineering Company, Chicago. Tube is centrifugally cast from Duraloy "HOM"*, a special high-nickel alloy developed by The Duraloy Company for hot strength in oxidizing atmospheres.

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TECHNICAL LITERATURE

(cont'd from p 43)

Books

Progress in Non-Destructive Testing: Vol. 2. *Edited by E. G. Stanford and J. H. Fearon. Macmillan Co., New York. 1960. Cloth, 6 by 10 in., 257 pp. Price $12.*

Subjects covered in the book are: 1) radiology with high energy x-rays; 2) mechanical testing of high polymers; 3) application of electrical methods for detecting flaws and for studying metal structures; 4) use of radioactive isotopes in nondestructive testing; 5) defect assessment using ultrasonic waves; 6) studies of aging and precipitation in metals using anelastic damping measurements; and 7) application of paramagnetic resonance to nondestructive testing.

The first volume of this annual series of books on nondestructive testing was reviewed in the May '60 issue of M/DE (p 196).

Books on Brass and Bronze.

Cast Bronze Bearing Design Manual. *Prepared by H. C. Rippel. Cast Bronze Bearing Design Inst., Inc., Evanston, Ill. 1960. Cloth, 8¼ by 11¼ in., 72 pp. Price $2*

Contains the latest theoretical and experimental information on bronze bearing design. The various chapters in the book give information on cast bronze sleeve bearings, bearing bronze selection, lubrication, bearing fabrication and assembly, and grooving specifications.

Ingot Brass and Bronze. *Brass and Bronze Ingot Inst., Chicago. 1960. Paper, 8½ by 11 in., 118 pp.*

Discusses nomenclature and classification of brass and bronze alloys, and gives chemical composition, properties, specifications and uses of various brass and bronze casting alloys.

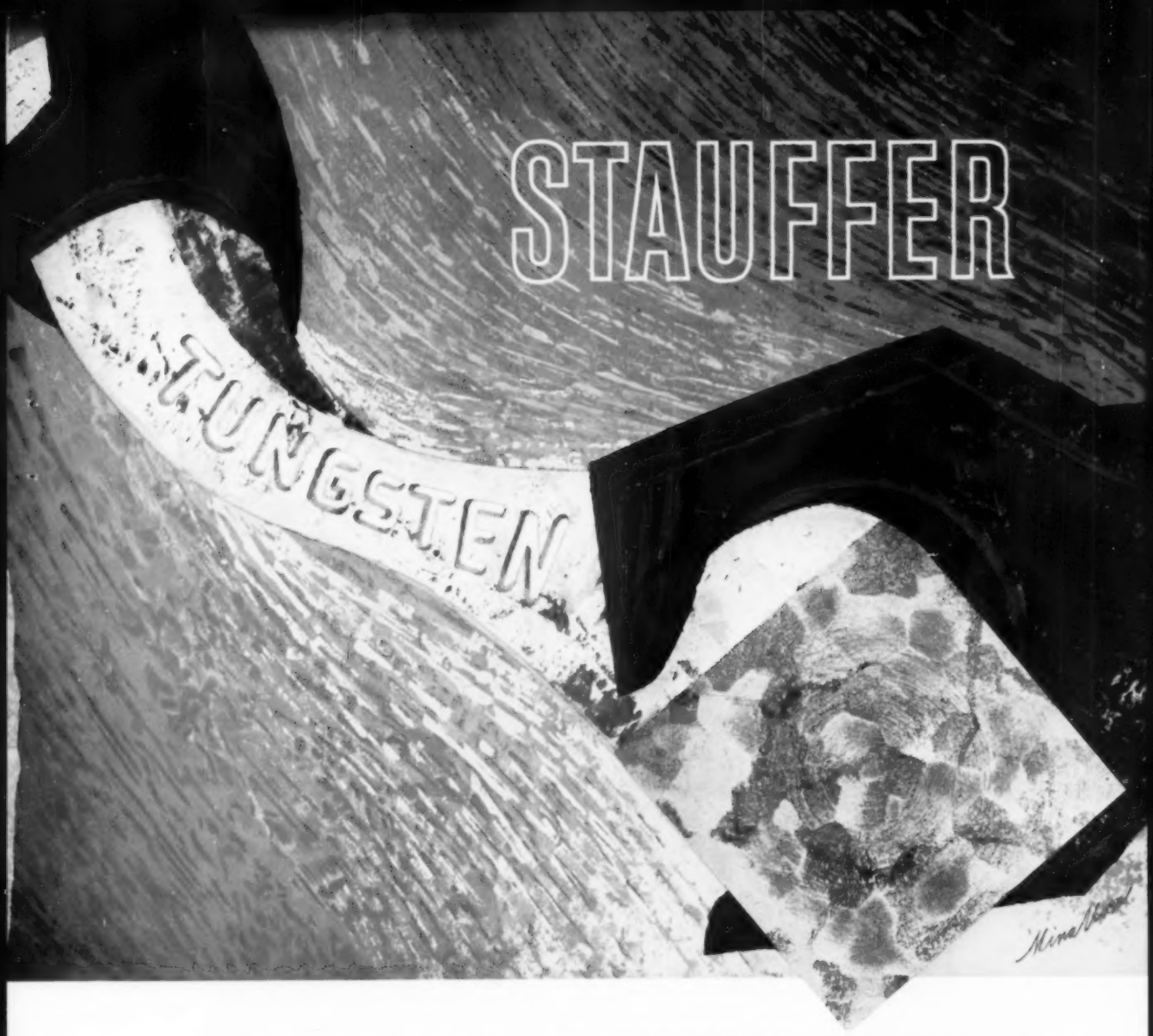
The Dymaxion World of Buckminster Fuller. *R. W. Marks. Reinhold Publishing Corp., New York. 1960. Cloth, 8¼ by 10¼ in., 232 pp. Price $12*

This book, a comprehensive review of Mr. Fuller's work in developing new structural concepts in housing, transportation and industry, is of general interest to many engineers. Of special interest to materials people is Mr. Fuller's imaginative use of new materials, especially lightweight materials for efficient load-bearing structures.

The book is illustrated with over 350 fully captioned photographs and drawings that graphically depict the plans and structures in Fuller's Dymaxion world. The Dymaxion idea is "to get from any type of structure the maximum net performance per unit of energy input."

Non-Crystalline Solids. *Edited by V. D. Frechette. John Wiley & Sons, Inc., New York. 1960. Cloth, 6 by 9 in., 554 pp. Price $15*

Subjects covered include: 1) thermal conductivity of glass; 2) amorphous sulfur and selenium; 3) anomalous properties of vitreous silica; 4) amorphous layers and their physical properties; 5) magnetic resonance studies of glasses; 6) strength of amorph-



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TECHNICAL LITERATURE

ous solids; 7) electron diffraction techniques for studying amorphous systems; and 8) network defects in noncrystalline solids.

Properties and Structure of Polymers. *A. V. Tobolsky. John Wiley & Sons, Inc., New York. 1960. Cloth, 6 by 9 in., 341 pp. Price $14.50*

Discusses mechanical behavior of polymers (e.g., fibers, rubber, plastics, etc.) in terms of molecular architecture and dynamics. The book shows how important problems in polymer chemistry can be solved by studying the mechanical behavior of polymers.

Photoconductivity of Solids. *R. H. Bube. John Wiley & Sons, Inc., New York. 1960. Cloth, 6 by 9 in., 481 pp. Price $14.75*

Discusses photoconductivity phenomena in various materials. The book contains a comprehensive bibliography of the literature on photoconductivity and a list of photoconducting materials that have been investigated to date.

Basics of Induction Heating: Vol. 1. *C. A. Tudbury. John F. Rider Publisher, Inc., New York. 1960. Paper, 6 by 9 in., 137 pp. Price $3.90*

Explains what induction heating is and how it works. The book also describes the more common types of induction heating equipment in use today.

Surface Effects on Spacecraft Materials. *Edited by F. J. Clauss. John Wiley & Sons, Inc., New York. 1960. Cloth, 8½ by 11 in., 420 pp. Price $11.50*

Discusses coatings for space vehicles, emissivity of materials near room temperature, material sublimation and surface effects in high vacuum, and effects of ultraviolet radiation on organic film-forming polymers. The book also discusses interplanetary dust distribution and erosion effects, atomic and molecular sputtering, surface phenomena and friction, and high temperature emissivity and spectral reflectance measurements.

ASTM Books on Materials. *American Society for Testing Materials, Philadelphia.*

1959 ASTM Proceedings: Vol. 59. *1960. Cloth, 6 by 9 in., 1424 pp. Price $12*

Contains technical papers and discussions on a wide variety of subjects pertaining to research and standards for materials.

Symposium on Electron Metallography. *Special Technical Publication No. 262. 1960. Cloth, 6 by 9 in., 134 pp. Price $4.25*

Subjects covered in this book include techniques for studying the morphology of phases in high temperature alloys, structure and growth of tin oxide, metallography of neutron irradiated steels, and dislocations in thin foils of stainless steel.

Symposium on Hydraulic Fluids. *Special Technical Publication No. 267. 1960. Cloth, 6 by 9 in., 104 pp. Price $3.75*

Discusses fire resistance and use of hydraulic fluids in automobiles, boats, aircraft and industry.

Literature Surveys on Influence of Stress Concentrations at Elevated Temperatures and the Effect of Non-Steady Load and Temperature Conditions on the Creep of Metals. *Special Technical Publication No. 260. 1960. Paper, 8½ by 11 in., 108 pp. Price $4.50*

Symposium on Education in Materials. *Special Technical Publication No. 263. 1960. Paper, 6 by 9 in., 56 pp. Price $2*

Contains chapters on the following subjects: ASTM views on engineering education; education in materials from an educator's viewpoint; industry's viewpoint on

TECHNICAL LITERATURE

education in materials; future challenges of the design engineer to the metal engineer and their bearing on the metal engineer's education; education in engineering; nature and properties of materials; and viewpoint of the civil engineer.

Reports

Strength of rubber TENSILE TEST REPRODUCIBILITY OF ELASTOMERIC VULCANIZATES. *S. L. Eisler, Rock Island Arsenal. Sept '58. 29 pp. Available from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D. C. Price $2.70 (microfilm), $4.80 (photocopy) (PB 138408).*

Results indicate that the size of filler particles and the presence of undispersed curative particles, which probably produce areas of overcure, are the two most important factors affecting reproducibility of tensile tests on elastomeric vulcanizates.

Fabricating columbium FABRICATION OF PURE COLUMBIUM. *W. D. Klopp and W. Hodge, Defense Metals Information Center, Sept '59. 9 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price 50¢ (PB 161184).*

Processing cermets TITANIUM CARBIDE-NICKEL CERMETS: PROCESSING AND JOINING. *J. Wulff, J. E. Cline and others, Massachusetts Institute of Technology. Dec. '58. 21 pp. Available from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D. C. Price $2.70 (microfilm), $4.80 (photocopy) (PB 144559).*

Titanium carbide cermets can be joined to high temperature alloys by vacuum diffusion. Fabrication of cermet parts can be done by cold forging cermet powder in a ductile envelope and subsequently sintering.

Research reports CUMULATIVE INDEX OF U. S. GOVERNMENT RESEARCH REPORTS: VOLUME 31 (JAN-JUNE 1959). *Available from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price $1.*

Protecting molybdenum EVALUATION OF PROTECTIVE COATINGS FOR MOLYBDENUM NOZZLE GUIDE VANES. *J. R. Giancola, Wright Air Development Center, June '59. 47 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1.25 (PB 151912).*

Thirty-seven molybdenum guide vanes with various coatings were evaluated for resistance to the effects of a jet engine exhaust stream at temperatures from 1860 to 1890 F. Results indicate that multilayer electrodeposited metallic coatings have the longest service life.

Corrosion resistant steel DEVELOPMENT OF A CORROSION-RESISTANT BEARING STEEL FOR SERVICE IN AIRCRAFT AT TEMPERATURES UP TO 1000 F. *G. Steven and T. V. Philip, Crucible Steel Co. of America. Oct. '59. 70 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1.75 (PB 161338).*

Corrosion resistance has been added to the high initial hardness, adequate temper resistance (600-900 F), and good dimensional stability of type 440C stainless steel by modifying it with vanadium, tungsten, molybdenum and cobalt.

Fatigue test data EFFECT OF CHANGING CYCLIC MODULUS ON BENDING FATIGUE STRENGTH: PART 2. *A. A. Blatherwick and B. J. Lazan, University of Minnesota, May*

HERE'S HOW STILL ANOTHER MANUFACTURER JOINS STAINLESS STEEL TUBING:

He uses Handy & Harman's BRAZE 630

He's one of many manufacturers and fabricators who have found—to their lasting satisfaction—that Handy & Harman silver alloy brazing is the final answer to stainless steel joining problems.

Super-Donic Manufacturing Company, Atlanta, Georgia, manufactures "Dual Arm Transmissions" for the dental industry. Most everybody has—at one time or another—seen and/or felt this unit in operation.

It is fabricated of small diameter 304 and 316 stainless steel tubing and, in its assembled form, consists of some 17 separate brazed joints. Joints must be strong, corrosion resistant and neat-appearing.

Each of the 17 joints is hand-torch brazed with Handy & Harman BRAZE 630 wire and HANDY FLUX TYPE B-1. There's no question that this is a unique application. There's no question, either, that the application is stainless steel. The ease and economy with which this manufacturer solves his problems can be just as readily applied to *your* stainless steel joining problems.

Strength, production speed, electrical and thermal conductivity, gas and liquid tightness and low cost are *natural* benefits of silver alloy brazing. We think it worth your while to learn more about this remarkable metal-joining method—we'll be glad to send you any information you ask for. Handy & Harman, 82 Fulton St., New York 38, N. Y.

FOR A GOOD START:
BULLETIN 20

This informative booklet gives a good picture of silver brazing and its benefits... includes details on alloys, heating methods, joint design and production techniques. Write for your copy.

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Toronto, Canada

For more information, turn to Reader Service card, circle No. 380

TECHNICAL LITERATURE

'59. 34 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1 (PB 151853)

Comparing results of different types of fatigue tests involving cyclic strain hardening materials is meaningless because of changing stress distribution, according to this report. Forged bars of high purity aluminum were subjected to constant strain, stress and moment-amplitude tests to determine the influence of changing cyclic secant modulus on bending fatigue. Results are compared with results of axial fatigue tests and other investigations.

Carburized steels ATLAS, HARDENABILITY OF CARBURIZED STEELS, *1960, Climax Molybdenum Co., Div. of American Metal Climax, Inc., New York.*

Over 125 charts show the effect of cooling rates on the Rockwell hardness of carburized molybdenum, carbon, nickel-chromium, nickel-chromium-molybdenum and other steels.

Corrosion of alloys A STUDY OF THE CORROSIVE EFFECTS OF THE COMBUSTION PRODUCTS OF BORON CONTAINING FUELS ON SELECTED HIGH TEMPERATURE MATERIALS. *F. J. Loprest and S. J. Tunkel, Thiokol Chemical Corp. Sept '59. 331 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $5 (PB 161581)*

Polypropylene fibers A NEW ITALIAN ASSERTION IN THE TEXTILE FIELDS: POLYPROPYLENE FIBERS. *G. Natta, 1960, 16 pp. Available from SLA Translation Center, John Crerar Library, 86 E. Randolph St., Chicago. Price $2.40 (microfilm), $3.30 (photocopy) (No. 60-14118)*

Discusses the production, properties and uses of polypropylene fibers. Polypropylene was synthetized by Natta in 1954.

Materials research SIXTH MATERIALS REVIEW. *A. Lyem, U. S. Army Chemical Warfare Laboratories. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $2.25 (PB 161563)*

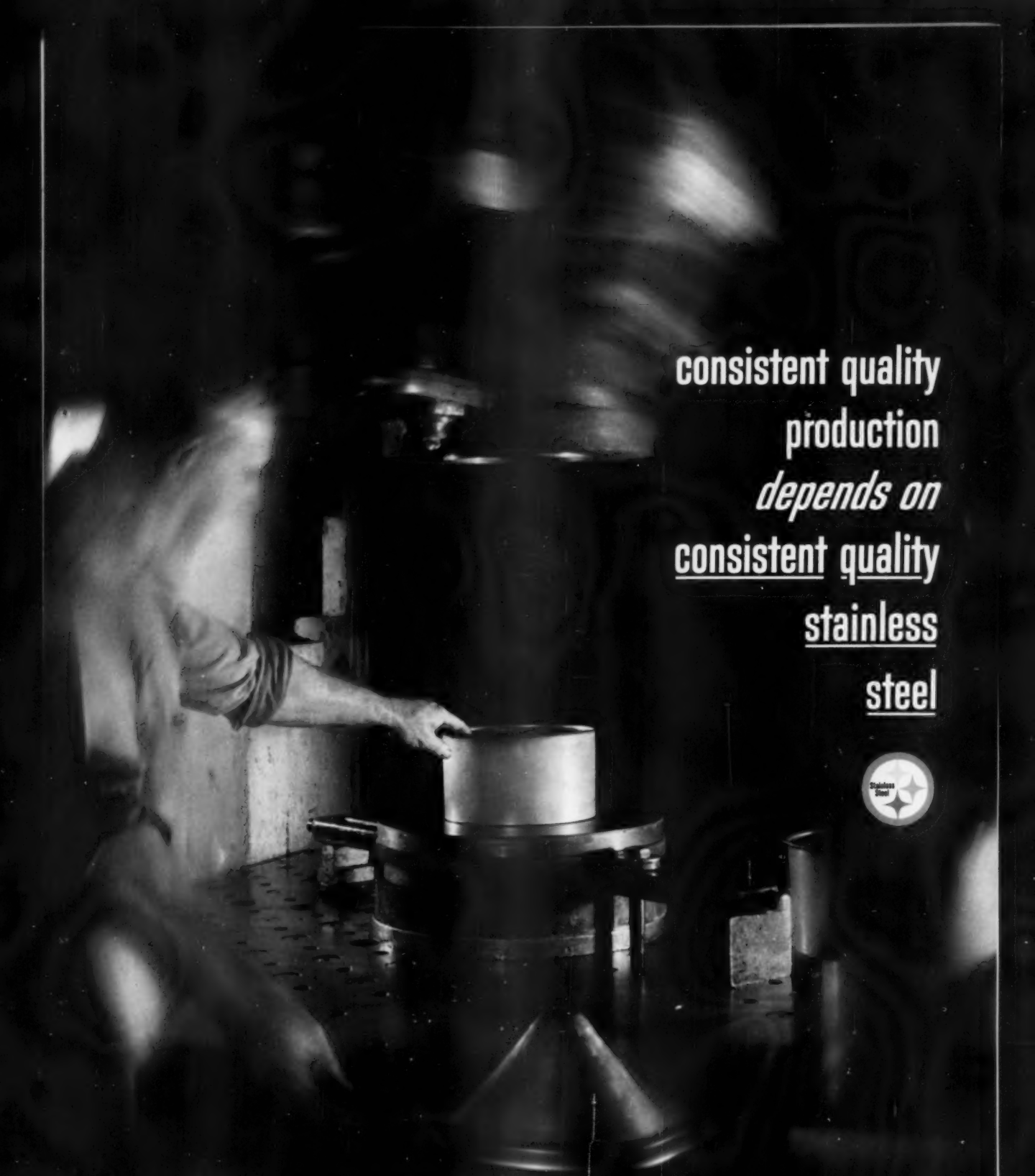
Information on important materials research here and abroad, principally in the polymer and plastics field.

Deposition of thin films RESEARCH ON THE PYROLYTIC DEPOSITION OF THIN FILMS. *F. V. Schossberger, S. Spriggs, F. Ticulka, E. Tompkins and E. Fagen, Armour Research Foundation. Oct '59. 45 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1.25 (PB 161417)*

Describes the preparation of thin films by pyrolytic deposition and other means for potential use in composite molecular electronics.

Corrosion of metals CORROSION OF METALS IN TROPICAL ENVIRONMENTS: PART 4, WROUGHT IRON. *C. R. Southwell and others, U. S. Naval Research Laboratory. Oct '59. 20 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price 50¢ (PB 151852)*

Information on corrosion of wrought iron, and mild, unalloyed structural steel after eight years' exposure in tropical environments. Greatest corrosion and pitting of the iron was noted after continuous immersion in sea water. Initial corrosion of wrought iron was greater in fresh water, but began decreasing after four years, virtually ceasing by the end of the eight-year test period. Both marine and inland atmospheres were more corrosive to wrought iron than to steel.



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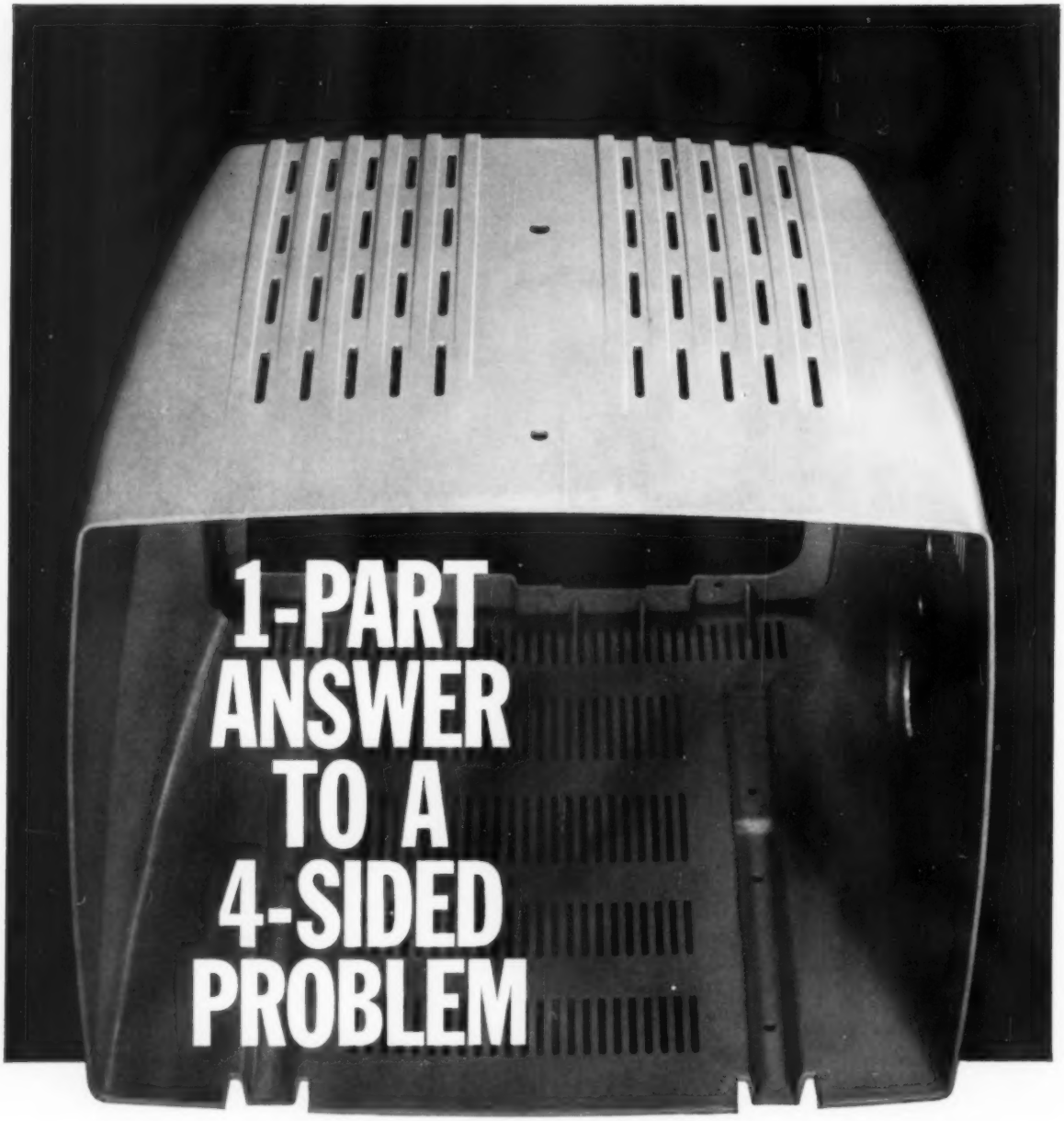

Just one shot on an injection press, and out comes this complicated 17-inch television cabinet weighing 1970 grams! Openings and grilles on all four sides required a mold opening in four directions. General American's ability to mold a cabinet like this means expanded opportunities in the use of plastics in all industries—since skilled die-makers working with production engineering experts assure the successful execution of the most demanding designs.

Have you thought that perhaps your part or product could be produced more efficiently and economically in plastics? With greater eye-appeal? Techniques developed by years of molding experience, together with the unequalled facilities at General American provide a source upon which you can call—and depend.

In plastics, as in so many other areas, *it pays to plan with General American.*

Plastics Division

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PLASTICS DIVISION GENERAL AMERICAN TRADE MARK

For more information, turn to Reader Service card, circle No. 371

(cont'd from p 18)

What's new IN MATERIALS

luminescent lamp produced by General Electric Co. The material is available from Cyanamid in development quantities at $27 per lb.

Properties

Two-mil cast film has a density of 0.043 lb per cu in. (1.2 gm per cu cm), a tensile strength of 5380 psi, elongation of 9% at break, and Young's modulus of 3.4 by 10^5 psi. Dielectric properties of the film are shown in Table 1.

Mechanical properties can be altered by incorporating plasticizers, such as bis(cyanoethyl)-phthalate. Plasticizers should have high dielectric constants and low dissipation factors.

Cyanocel can be molded at 390 F under 6000 psi pressure to provide a relatively strong molding which, under dry conditions, has the same basic dielectric characteristics as the films. Properties of moldings are shown in Table 2.

TABLE 1—ELECTRICAL PROPERTIES OF CYANOCEL FILM
(2 Mils Thick, 73 F, 50% RH)

Dielectric Strength (short time), v/mil	
In Oil (2.5 mils thick)	1860
In Air (2.5 mils thick; 26% RH)	1440
Dielectric Constant[a]	
100 Cps	13.0
1 Kc	12.8
10 Kc	12.3
100 Kc	11.7
1 Mc	10.0
Dissipation Factor[a]	
100 Cps	< 0.02
1 Kc	< 0.02
10 Kc	0.02
100 Kc	0.04
1 Mc	0.12

[a] Lewis, C. W. and Hogle, D. H., *Jnl. Polymer Sci*, 21, 411, '56.

TABLE 2—PROPERTIES OF CYANOCEL MOLDINGS
(73 F, 50% RH Except As Noted)

PHYSICAL PROPERTIES	
Flexural Strength, 1000 psi	4.2
Modulus of Elasticity, 10^5 psi	3.2
Tensile Strength, 1000 psi	1.8
Elongation, %	1.11
Tensile Impact Strength, ft-lb/sq in.	4.3
Rockwell Hardness	M15
Heat Dist Temp (264 psi), F	280
Flammability, ipm	1
Water Absorption (24 hr), %	2.6
Coef of Lin Ther Exp, per °F	5.2×10^{-5}
Weight Loss (48 hr at 220 F)	1.9
ELECTRICAL PROPERTIES	
Dielectric Constant	
60 Cps	18.8
10^3 Cps	15.6
10^6 Cps	12.6
Dielectric Constant (desiccated)	
60 Cps	16.8
10^3 Cps	14.8
10^6 Cps	12.5
Dissipation Factor	
60 Cps	0.165
10^3 Cps	0.039
10^6 Cps	0.180
Dissipation Factor (desiccated)	
60 Cps	0.048
10^3 Cps	0.019
10^6 Cps	0.125
Volume Resistivity, ohm-cm	6.0×10^9
Surface Resistivity, ohms	5.3×10^{11}
Insulation Resistance, ohms	1.0×10^{10}
Dielectric Strength (in oil), v/mil	
Short Time	260
Step by Step	160
Arc Resistance	Pccr

For more information, circle No. 611

Copper Alloy Resists Corrosion

American Brass Co., Waterbury, Conn. has announced the production and commercial availability of Cunisil-837, an alloy of 97.5% copper, 1.8% nickel and 0.6% silicon.

The company says the alloy has many of the desired qualities of silicon bronze. Its machinability rating, based on 100 for free-cutting brass rod, is approximately 40. A big use for the alloy will probably be in electrical equipment.

Properties, heat treatment

The new alloy has high tensile strength, high yield strength, high electrical conductivity (30 - 42% IACS as heat treated), and good corrosion resistance. It has a density

What's new IN MATERIALS

MECHANICAL PROPERTIES OF CUNISIL-837

Min Tensile Strength, psi	90,000
Min Yield Strength (0.5% extension under load), psi	70,000
Min Elongation, %	8
Angle of Bend on Radius Equal to Diameter, deg	90

of 0.322 lb per cu in., and its linear coefficient of thermal expansion is 0.0000098 per °F over the temperature range 68 to 572 F.

The developer says most of the nickel and silicon in the heat treated alloy are present as an intermetallic compound of nickel silicide, and it is the precipitation of nickel silicide in the form of submicroscopic particles by a relatively low temperature heat treatment (approx. 840 F) that accounts largely for the distinctive properties of the alloy.

Prior to the hardening heat treatment, the alloy is brought to a proper condition for hardening by giving it a solution anneal at about 1470 F, and then quenching. The developer says that at this stage the alloy is quite soft and in a condition for drastic cold working.

Availability

The new copper alloy is made in round rod, with or without the final precipitation hardening heat treatment. The rod is supplied in straight lengths in diameters from 3/16 to 1 in., and in coils 3/16 to ⅝ in. in dia. **KEY NO. 612**

Polyethylene Resins Extruded Into Pipe

Three new polyethylene compounds are available for extrusion into pipe.

The materials are designed to meet the requirements for Type II and Type III polyethylene pipe as defined in the proposed revision of commercial standard CS 197-59. The standard was prepared by the Society of the Plastics Industry.

All three materials carry the National Sanitation Foundation's seal of approval for transmission of potable water.

DGDA-2033 Black 4865 is a Type III, higher density polyethylene pipe compound introduced by Union Car-

What's new IN MATERIALS

bide Plastics Co., Div. of Union Carbide Corp., 270 Park Ave., New York 17. The compound is said to have favorable long-term stress properties, combined with easy processability in conventional equipment at high extrusion rates. KEY NO. 613

Tenite 2521 E-60099 is a Type II, medium density compound introduced by Eastman Chemical Products, Inc., 260 Madison Ave., New York 16. It sells for 35¢ per lb.

Tenite 2811 E-80010 is a Type III, higher density compound also introduced by Eastman Chemical. It sells for 38¢ per lb.

Both Tenite formulations are said to yield polyethylene pipe at fast production rates with smooth, glossy surfaces both inside and outside.

KEY NO. 614

Compound Cleans, Phosphates Metals

Development of a new phosphating compound for simultaneous cleaning and phosphating of iron, steel and zinc has been announced by Turco Products, Inc., 24600 S. Main St., Wilmington, Calif.

Called Paintite, the compound is said to produce a light, tight, smooth and uniform phosphate coating that assures paint adhesion and prevents rapid post-rusting of metals before painting. It is said to be extremely low foaming, low sludging and free rinsing, and to require a minimum of temperature control when used between 140 and 180 F.

KEY NO. 615

Irradiated Tubing Fits Over Irregular Shapes

A new irradiated polyolefin tubing heat shrinks to form a tight bond over irregular shapes. Called Hyshrink, it is available from Sequoia Wire & Cable Co., a subsidiary of Anaconda Wire & Cable Co., 25 Broadway, New York 4.

The tubing is supplied in a variety of colors, in sizes from 0.050 to 0.348 in. i.d., in lengths of 4 ft.

How tubing is applied

The flexible tubing can be slipped easily in its expanded form over

A new family of materials to meet special problems

•

SHOCK
STRESS
ABRASION

AMSCO® ALLOYS

In addition to austenitic manganese steel castings—long known for their exceptional service life in mining, construction, quarrying and milling applications—Amsco now offers *seven* other ferrous alloy materials. These include specially alloyed manganese steels, chrome moly steels, high strength alloyed steels and alloyed cast irons.

Each has particular advantages for specific service requirements, involving various combinations of impact, stress and wear. Check the brief facts on these alloys below. Then call in an Amsco sales engineer to assist in selecting the *one best* material to meet your application needs.

AMSCO ALLOY DESIGNATION	DESCRIPTION AND USES	MECHANICAL PROPERTIES
MY	Heat-treated, chromium alloyed manganese steel ... for use in light-to-medium weight castings requiring modest improvement in growth and distortion, and increased stiffness.	tensile strength ..... 120,000 psi yield strength ..... 56,000 psi elongation ..... 45% reduction of area 30%
MML	Heat-treated, molybdenum alloyed manganese steel ... for castings requiring improved weldability, for extremely heavy metal sections, and castings exposed to excessive heating environments.	tensile strength ..... 120,000 psi yield strength ..... 52,000 psi elongation ..... 50% reduction of area 40%
MMH	Heat-treated, molybdenum alloyed manganese steel ... for use in castings requiring optimum mechanical properties and wear resistance. Provides improved stiffness and resistance to peening and flow.	tensile strength ..... 120,000 psi yield strength ..... 65,000 psi elongation ..... 20% reduction of area 18%
CML	Heat-treated, air-hardening chrome-moly steel ... for casting applications involving scouring or grinding wear. Suitable for more complex casting designs.	tensile strength ..... 155,000 psi yield strength ..... 130,000 psi elongation ..... 10% reduction of area ..... 15% hardness ..... 275-375 BHN
CMH	Heat-treated, air-hardening chrome-moly steel ... exhibits potentially improved wear resistance over CML (above), when shock loading is not sufficiently severe to cause breakage.	tensile strength ..... 155,000 psi yield strength ..... 130,000 psi elongation ..... 6% reduction of area ..... 7% hardness ..... 300-400 BHN
CS	Martensitic, multiple alloy steel with chromium, nickel and molybdenum ... combines high mechanical strength with good abrasion and wear resistance.	tensile strength ..... 220,000 psi yield strength ..... 195,000 psi elongation ..... 8% reduction of area ..... 20% hardness ..... 300-500 BHN
HC	High chromium cast iron ... provides outstanding abrasive wear resistance, where impact force is low but particle velocity and scouring forces are high.	tensile strength ..... 60,000 psi transverse strength ..... 7,000 lbs. deflection ..... 0.12 in. hardness ..... 400-600 BHN

For further information
—write for technical bulletin on "Amsco Ferrous Alloy Castings".

AMERICAN Brake Shoe COMPANY

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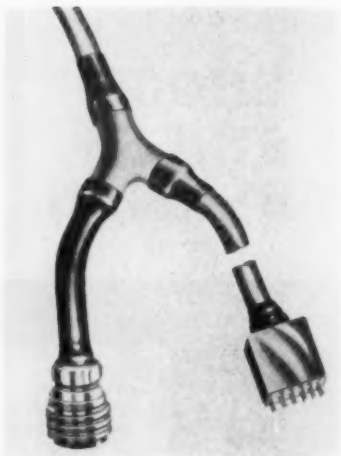
American Manganese Steel Division • Chicago Heights, Illinois

For more information, turn to Reader Service card, circle No. 327

What's new IN MATERIALS



***Cable harness** shows four possible applications (dark areas) for irradiated tubing.*

terminals, connectors, wire, cable, conduit and other electrical and electronic parts. Upon application of heat (275 F), the tubing shrinks in diameter to form a strong mechanical bond.

According to the producer, heating will not affect flexibility of the irradiated tubing. The product is said to have excellent shelf life and will remain at its expanded diameter until heated.

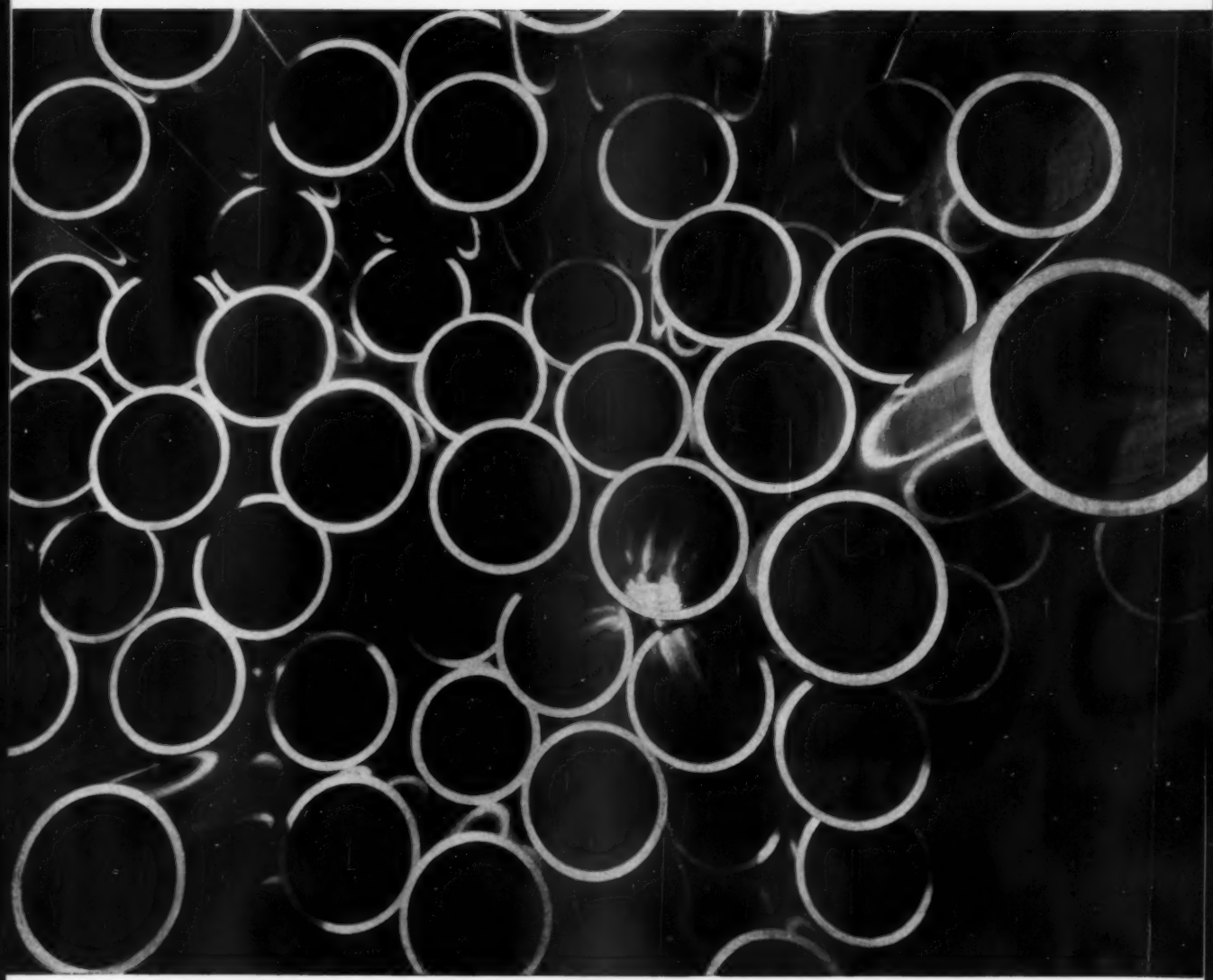
Tubing is flame retardant

The new product is flame retardant, thermally stable, and resistant to most chemicals, JP-4 jet fuel and Skydrol hydraulic fluid.

The tubing is also resistant to fungus growth, gives off no toxic fumes when heated, shows a weight increase of 0.01% or less after immersion in water, and remains flexible and strong over the temperature range 67 to 275 F. Within this temperature range the applied tubing will not melt, harden, flow, run, crack or blister, according to the producer.

Sequoia's irradiated polyolefin

AWARDS COMPETITION — Entries for the 5th annual Awards Competition for the Best Use of Materials in Product Design are due Feb 1, 1961. See p 123 for details.



Look at the dimensional accuracy and smoothness

You can reduce the costs and processing time of parts-making by using USS National Electric-Resistance Welded Mechanical Tubing. It eliminates drilling operations. It lets you replace drills with simple, less expensive boring tools. Mechanical Tubing reduces tool wear and tool changes.

USS National Electric Welded Mechanical Tubing is an ideal load-carrying member. It resists bending stresses equally in all directions and gives you a superior cross section. It absorbs and localizes shock. In torsion, it provides better material distribution. And for a given weight, mechanical tubing withstands more load than other sections.

USS National Electric Welded Mechanical Tubing is available in cold-drawn or hot-rolled sizes ⅜″ thru 5½″ and in wall thicknesses .035″ to .250″. It can be obtained from National Tube Distributors located throughout the country. They will gladly show you how to use USS National Welded Mechanical Tubing in your next application. *See your USS National Tube Distributor.*

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National Tube Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Supply Division
United States Steel Export Company, New York

For more information, turn to Reader Service card, circle No. 411

tubing is similar to W. R. Grace's Cryovac irradiated polyethylene film introduced earlier this year (see M/DE, May '60, p 218).

KEY NO. 616

Urethane Elastomers Sold in Various Grades

A new urethane elastomer is being supplied in a variety of formulations ranging from very soft to hard, and from flexible to rigid in construction.

The elastomer, called Uscothane and developed by U. S. Rubber Co., 1230 Avenue of the Americas, New York 20, does not differ materially from other urethanes now on the market: the difference lies in the broad scope of compounds offered, according to the developer.

Properties

U. S. Rubber says the new material's properties are controlled not only by polymer chemistry, but also by time and temperature of cure, and by mixing conditions. The material can be made to fit an almost infinite number of exacting performance requirements by varying these conditions of preparation.

Tests show the material has good resistance to ozone attack, and is impervious to oil and most common commercial solvents. It can be used over the temperature ranges of —30

***Air car** rides on a cushion of air that is directed straight down to the ground by a urethane rubber skirt that runs the circumference of the vehicle.*

STST*

*Superior Tool Steel Tubing

ODDS: 1000 TO 1 TO CUT COSTS, IMPROVE PERFORMANCE IN 1001 DIFFERENT APPLICATIONS

Superior tool steel tubing is an excellent material for tools, but equally good for 1001 other applications. Odds are that it will cut costs and improve performance wherever it is used. Type E-52100, an oil hardening grade of high-carbon and chromium alloy steel, has been widely used for such diverse applications as thread guides on hosiery knitting machines, nylon yarn guides, ball bearing races, nozzles for blast cleaning equipment, gear and pinion parts, dental instruments and extrusion mandrels. Type E-1095, a high-carbon steel tubing, is serving as applicators for jewelers' oilers, leather and paper punches, and surgical instruments.

Perhaps you have an application that can benefit from high strength and hardness, good wear resistance, abrasion resistance, shock resistance, and notch toughness. In that case, consider Superior tool steel tubing before you go any farther. It could give you a better product at a lower cost. Send for Data Memorandum #14, a handy guide to your thinking. Superior Tube Company, 2006 Germantown Ave., Norristown, Pa.

Steel

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The big name in small tubing

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All analyses .010 in. to ⅝ in. OD—certain analyses in light walls up to 2½ in. OD

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to 250 F in dry service and —30 to 160 F in wet service.

Product used on air car

A recently introduced air car (see accompanying photo) uses the new material as a skirt around the circumference of the vehicle. Skirts made of the material have lasted more than three months during a recent testing program, replacing conventional rubber skirts that wore out daily from constant abrasion, tearing and gouging as the vehicle passed over gravel, concrete and other abrasive materials.

Other uses foreseen for Uscothane include chute linings, scrapers, rings, bumper pads, belt covers, caster wheels, power transmission belting, traction cleats, friction drives and gears.

Several formulations sold as stock items

For experimental work, U. S. Rubber is offering several formulations of the urethane elastomer as stock items. They include standard formulations of the elastomer in 1, 2 and 4-in. dia rods and in 3 by 10-ft fabric-backed slab stock, ¼ in. thick. Rods of a special compound with low coefficient of friction are also available.

The material can be bonded to almost any fabric and to many metals in sheet or shaped forms. The developer says successful metal-backed constructions have been made with aluminum, cast iron and steel.

KEY NO. 617

Indium-Clad Aluminum for Semiconductors

Aluminum preforms clad on both sides with indium are available for semiconductor "P" junctions from Accurate Specialties Co., Inc., Hackensack, N. J.

Melting indium onto the aluminum blank is said to eliminate the troublesome oxide films formed in mechanical bonding. Indium-aluminum alloys are desirable junction materials because introduction of aluminum into germanium crystals improves emitter efficiency. An oxide film makes it very difficult to wet the germanium.

In the metallurgical bonding method, the indium cladding melts

PRODUCT-DESIGN BRIEFS FROM DUREZ

- What a solvent cement can do
- Something new in electrical insulation
- A bulletin on plastics

Stuck?

A good adhesive does a lot more than stick two things together. You can use

today's solvent-type adhesives to:

- smooth out surface contours (as in brake linings and in jet aircraft skins, where adhesives can eliminate the need for projecting rivets);
- distribute stress uniformly over a surface, rather than concentrating it at welded or riveted points;
- build up large structural members from many small components;
- reduce galvanic action between dissimilar metals, and so lessen the risk of corrosion.

One super-sticker in this class sets with only contact pressure and at room temperature; adheres very well to metal, wood, phenolic laminates, glass, and rubber. Block shear tests show 4500 psi at room temperature, and tensile strength is 10,000 psi. The cement has excellent resistance to all ordinary solvents, water, oils, alkalies, and acids; has high capillary attraction and does not shrink.

We don't make adhesives. We do make heat-setting phenolic resins that give many of the newer adhesives more gripping power and more *permanence*. Next time you have a fastening problem, give these new solvent-type adhesives a chance to show you what they can do.

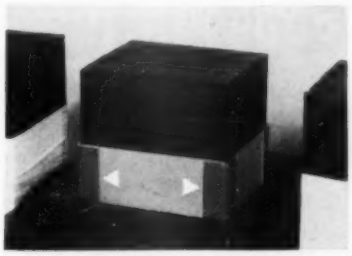
Stock insulation shapes

This insulation idea solves three engineering problems at once in a dry-type transformer. You'd find the same approach helpful in a circuit breaker, a panel, or other heavy-duty electrical gear.

See the plastic angle pieces (below)? They insulate the corners of the laminated steel core from the windings, at the high-stress areas. They take the place of roll-formed fiber. Advantages:

1. Greater mechanical strength. This ends cracking or breaking of insulation when windings are forced into position.
2. Better resistance to moisture. The insulation doesn't swell or shrink, maintains its dielectric strength under the clammiest conditions.
3. Higher heat resistance. The angle is made with glass-reinforced Hetron,® our inherently heat-resistant polyester resin. It meets NEMA GPO-1 specifications, and has UL-recognized flame retardance. It is designed for equipment operating at Class B temperatures (266°F.).

Now for the clincher. You can get flame-retardant structural insulation like this *from stock*—in a wide range of cross-section shapes including channels, in widths up to $9\frac{21}{32}$ inches, lengths to 76 inches.



PRECISION WELDER AND FLEXOPRESS CORP.

You get them not from us but from the manufacturer, The Glastic Corporation, 4321 Glenridge Road, Cleveland 21, Ohio. The Glastic people will be glad to send you details on stock channels and angles if you write to them.

Facts without a file

What does a man do when he wants to know more about Durez plastics?

He looks in Sweet's File. There he finds eight pages packed with the what, how, when, where, and why of using Durez materials—phenolic and diallyl phthalate molding compounds, Hetron polyester resins, phenolic resins.

What if he hasn't got Sweet's File handy? He sends us the coupon below, requesting Durez *Bulletin D400*. The same fact-filled eight pages come to him posthaste.

For more information on Durez materials mentioned above, check here:

- ☐ Phenolic resins (12-page bulletin listing applications)
- ☐ Hetron fire-retardant polyester resins (data file, including names of fabricators)
- ☐ Durez plastics *(Bulletin D400)*

Clip and mail to us with your name, title, company address. *(When requesting samples, please use business letterhead)*

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HOOKER CHEMICAL CORPORATION

HOOKER CHEMICALS PLASTICS

For more information, turn to Reader Service card, circle No. 359

What's new IN MATERIALS

first at 750 F while protecting the aluminum from oxide formation. It then carries the dissolved aluminum into the germanium crystal interface.

The new tri-clad material is available in preforms, such as ultra-precise disks and washers, with a wide variety of cladding thicknesses.

KEY NO. 618

Vinyl Extrusions

Crane Plastics, Inc., 500 Hutton Pl., Columbus 15, Ohio says it is the first custom plastics extruder to develop and perfect production techniques for making multi-hollow, high impact, rigid vinyl extrusions. Details as to how the hollow plastics parts are made have not been revealed.

One such product is an extrusion with six hollow sections. It is used as a frame for windows and doors, replacing conventional wood and metal frames. Crane says the extruded vinyl frames do not warp, swell, fade or stain. They also operate smoothly and quietly, and have good chemical and impact resistance.

Crane says it also makes hollow and multi-hollow extrusions out of polyethylene, cellulose acetate, acrylic, polypropylene, ethyl cellulose, polystyrene and other plastics.

KEY NO. 619

Mica Insulation High in Dielectric Strength

A new mica electrical insulation is said to have 150% greater dielectric strength than either mica papers or built-up mica.

Developed by the Insulating Materials Dept. of General Electric Co., Schenectady, N. Y., the new insulation consists of silicone-bonded mica mat sandwiched between layers of silicone-varnished glass cloth.

The mica insulation has a dielectric strength of 1400 v per mil and is designed for both Class F (310 F) and Class H (360 F) applications. It is expected to be used primarily as slot insulation in a. c. motors, and as layer insulation in transformers.

The mica insulation has a cut-

KNOW YOUR ALLOY STEELS . . .

This is one of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

Thermal Stress-Relieving of Alloy Steels

In the production of alloy steel bars and parts made of alloy steel, stresses are sometimes set up, and these stresses must be relieved before optimum results can be expected. Two general types of stress-relieving are practiced—thermal and mechanical. In this discussion we shall consider only the former.

There are several important reasons for thermal stress-relieving. Among these are the following:

(1) The first and most fundamental purpose is to reduce residual stresses that might prove harmful in actual service. In the production of quenched and tempered alloy steel bars, machine-straightening is necessary. This induces residual stresses in varying degrees. Bars are usually stress-relieved after the straightening operation. When the bars are subjected to later processing that sets up additional stresses, subsequent stress-relieving may be necessary.

(2) A second major purpose of thermal stress-relieving is to improve the dimensional stability of parts requiring close tolerances. For example, in rough-machining, residual stresses are sometimes introduced, and these should be relieved if dimensional stability is to be assured during the finish-machining.

(3) Thermal stress-relieving is also recommended as a means of restoring mechanical properties (especially ductility) after certain types of cold-working. Moreover, it is required by the "safe-welding" grades of alloy steels after a welding operation has been completed.

Alloy bars are commonly stress-relieved in furnaces. Temperatures under the transformation range are employed, and they are usually in the area from 850 deg to 1200 deg F. The amount of time required in the furnace will vary, being influenced by grade of steel, magnitude of residual stresses caused by prior processing, and mass effect of steel being heated. After the bars have been removed from the furnace, they are allowed to cool in still air to room temperature.

In the case of quenched and tempered alloy bars, the stress-relieving temperature should be about 100 deg F less than the tempering temperature. Should the stress-relieving temperature exceed the tempering temperature, the mechanical properties will be altered.

Items other than bars (parts, for example) can be wholly or selectively stress-relieved. If the furnace method is used, the entire piece is of course subjected to the heat; selective relieving is impossible. However, if a liquid salt bath or induction heating is used, the piece can be given overall relief or selective relief, whichever is desired.

Detailed information about stress-relieving is available through Bethlehem's technical staff. And remember that we can furnish the entire range of AISI standard alloy steels, as well as all carbon grades.

This series of alloy steel advertisements is now available as a compact booklet, "Quick Facts about Alloy Steels." If you would like a free copy, please address your request to Publications Department, Bethlehem Steel Company, Bethlehem, Pa.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

through resistance of 16,000 psi at 200 F. Tests show it has three times greater cut-through resistance than any mica paper now available.

The new insulation is available in thicknesses of 8, 10, 12, 15, 20 and 25 mils. It is said to be compatible with most impregnating varnishes.

KEY NO. 620

Tungsten Alloy Ingots Sold in Large Sizes

Ingots containing 85% tungsten and 15% molybdenum are being made available in sizes up to 11 in. in dia by Climax Molybdenum Co., Div. of American Metal Climax, Inc., 1270 Avenue of the Americas New York 20.

R. E. Warriner, vice president of sales for Climax Molybdenum says: "To the best of our knowledge, no other full density alloy that will withstand temperatures over 5500 F is available commercially in such large sizes."

The ingots are supplied in three forms: as cast, machine turned, and heat treated to relieve casting stresses and facilitate machining.

The tungsten-molybdenum alloy is now being used in applications such as nozzles for missiles, and missile vanes and trajectory controls.

KEY NO. 621

Paint Adheres Well to Treated Aluminum

A new type of chemical treatment is said to greatly improve the adhesion of paints, lacquers, enamels, adhesives and other coatings to the surface of aluminum. Reason: a chemical reaction produces an organic surface on aluminum that has good compatibility with subsequently applied organic coatings.

The chemical treatment is called Chemlock 720 and is marketed by Hughson Chemical Co., Div. of Lord Mfg. Co., Erie, Pa.

According to the producer, Chemlok 720 is a cathodic treatment, preventing undercutting and blistering of paint films. The chemical treatment does not affect the base color of aluminum, and can be used with

What every designer should know about...

High nickel alloy cold wound springs for high temperature service

When made of suitable materials, particularly the age-hardenable alloys, cold-wound springs will provide somewhat higher mechanical properties and design stresses than those obtainable in hot-wound springs.

The heat treatments used for the nickel alloys, other than triple heat-treated Spring Temper Inconel "X"*, are such that distortion during aging or stress relieving is minimal. For triple heat-treated Inconel "X" springs it is necessary to mount springs on a heat-resisting mandrel to avoid distortion.

All of the high-nickel alloy springs retain outstanding spring characteristics at sub-zero temperatures down to −320° F or lower. Some increase is imparted to tensile and shear properties with no significant or adverse effect on elongation or impact properties.

The nickel-copper alloy "K" Monel* and the nickel-chromium alloys Inconel* and Inconel "X" are nonmagnetic and the cold work resulting from cold drawing to spring temper or cold winding have no adverse effect on their low permeability.

The nickel-magnesium alloy "Permanickel"* has the highest electrical conductivity of all of these high-nickel alloys and as a result has found useful application for springs of limited current-carrying capacity.

Grain coarsen annealing of Spring Temper Inconel and No. 1 Temper Inconel "X" has been found to significantly improve resistance to relaxation at elevated temperatures.

One of the outstanding characteristics of Inconel and Inconel "X" is their resistance to relaxation at elevated temperatures, at design stresses, corrected for curvature, that will permit useful designs without consuming excess space.

A useful guide for selection of materials for elevated-temperature service is shown below.

GUIDE FOR USE OF NICKEL ALLOY COLD WOUND SPRINGS[1]

Alloy	Temper	Heat Treatment[2]	Service Temp.-°F	Stress; 1000 psi[3]
Monel* Ni-Cu	Spring	Str. Rel.	Up to 450	60-40
"K" Monel* Ni-Cu	Spring	Aged	Up to 500	65-50
Duranickel* Ni-Al	Spring	Aged	Up to 600	70-60
Permanickel* Ni-Mg	Spring	Aged	Up to 600	70-60
Inconel* Ni-Cr	Spring	[4]Str. Rel.	Up to 750	75-60
Inconel "X"* Ni-Cr	Spring	Aged	Up to 700	100-85
Inconel "X"* Ni-Cr	No. 1	[4]Aged	Up to 1000	70-45
Inconel "X"* Ni-Cr	Spring	Triple H.T.	900 to 1200	55-30

1. Wire sizes up to 7/16 to ¾ diam., depending on material and spring index.

2. Grain coarsen annealed prior to final cold draw.

3. Will vary depending on alloy, temper and end use — consult revised Technical Bulletin T-35.

4. For elevated-temperature service, lower stresses applicable to higher temperatures — consult T-35.

Inconel and Inconel "X" alloys have outstanding resistance to high purity waters containing chlorides, to hot fatty acids and most neutral and alkaline salt solutions. The alloys remain bright indoors indefinitely.

In many cases Inconel and Inconel "X" offer cost advantages, both hot and cold wound, over high alloy steels for springs intended or elevated-temperature service.

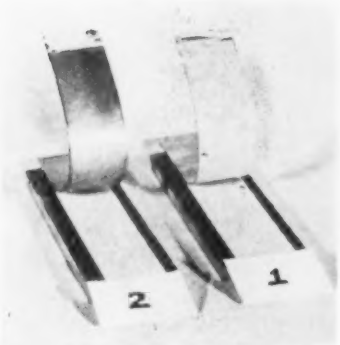
Helpful New Technical Bulletin T-35, "High Nickel Alloy Helical Springs" gives newly-developed information on test methods for relaxation; relaxation data and recommended stresses; effects of grain coarsen annealing; triple heated Spring-Temper Inconel "X" for service up to 1200° F; and hot forming practices. Write today for newly-revised Technical Bulletin T-35.

*Inco trademark

HUNTINGTON ALLOY PRODUCTS DIVISION
The International Nickel Company, Inc.
Huntington 17, West Virginia

INCO TRADE MARK **ALLOY PRODUCTS**

What's new IN MATERIALS



Peel test results: *No. 1 is a piece of aluminum treated with Chemlock 720. Paint adheres firmly, failing cohesively in paint layer. No. 2 is an improperly treated piece of aluminum in which the paint peels off, leaving a bare strip.*

all types of paints and clear coatings. The treatment is adaptable to batch or continuous processing with either spray or immersion equipment.

Tests by Hughson show that adhesion obtained with the product is stronger than the applied coating, i.e., the paint film fails cohesively rather than by stripping off an aluminum specimen (see accompanying photo).

KEY NO. 622

Lightweight Locknut Rated at 145,000 Psi

Improved performance and reliability in high temperature applications are provided by a new self-locking nut now available from Standard Pressed Steel Co., Jenkintown, Pa.

Locknut exceeds aerospace industry's standard

The company's locknut, called FN 1014, exceeds the tensile strength, maximum usage temperature, magnetic permeability and locking torque requirements of the aerospace industry's NAS 1291C nut standard. In addition, it is said to be the lightest-weight locknut available for its rated strength and temperature.

In comparison with minimum NAS 1291C requirements, the new nut is rated at 145,000 psi tensile strength

rather than 125,000 psi. Temperature limit is 1000 F rather than 800 F. Corrosion resistance is rated as excellent at temperatures up to 1000 F.

The locknut is forged from A-286 alloy and is silver plated to AMS 2410 standards.

Alternate electrical series

An alternate series, designated FN 1014M, is finished with a molybdenum disulfide dry film lubricant instead of the silver plate. The series is especially intended for electronic and other electrical applications where silver plating is not desired but low magnetic permeability is required. **KEY NO. 623**

Nine New Epoxies for Casting, Impregnating

Nine new epoxy resins have been introduced recently for a variety of applications including casting, encapsulating and impregnating.

1. Three flexible resins

Three flexible epoxy resins, called X-2673.2, X-2673.6 and X-2674, are now available from Dow Chemical Co., Midland, Mich. They are designed to give increased flexibility and toughness to conventional epoxy systems.

The materials are described as light colored, low viscosity fluids that can be blended with common liquid and solid epoxies, and with Dow's epoxy novolac DEN 438 (see M/DE, Jan. '60, p. 9). According to Dow, flexure strength of conventional epoxy resin systems can be increased 25 to 40% by using the new resins. But the company says use of the flexible resins affects other properties; namely, water, chemical and solvent resistance, and heat distortion.

The new resins are expected to find use in castings, laminates, adhesives and coatings. **KEY NO. 624**

2. Casting resins

Emerson & Cuming, Inc., Canton, Mass. has introduced a fire retardant epoxy casting resin that can be cured at room temperature. The material is said to have excellent adhesion to metals, plastics and ceramics. The material, called Stycast 1231, remains stable over the tem-

✓ check these cost-cutting NEW IDEAS from SETKO

then check the coupon below for full information and free test samples

IDEA #1 "NU-CUP® POINT GRIPS THINWALL TUBING BETTER THAN ALL OTHERS TESTED!"

42% sharper angle on point cuts deep into the metal in a circular manner!

CONVENTIONAL

An independent manufacturer tested all types of points to find the one that would hold best . . . and perform most dependably. He chose NU-CUP. Could you use this idea? Check No. 1. (Name of Mfr. on request.)

Set Screw & Mfg. Co.

IDEA #2 THIS COST-CUTTER TAKES 50% MORE TORQUE BECAUSE OF SLABBED HEAD CONSTRUCTION!

Costs less than comparable hexagon head set screws.

If you are having trouble with stripped heads or insufficient holding power, chances are the Setko Slabbed Head Set Screws are just the idea you need . . . Available in all points and metals. Check No. 2!

Set Screw & Mfg. Co.

IDEA #3 IS VIBRATION CAUSING LOOSE SET SCREWS ON YOUR PRODUCTS? . . . ELIMINATE THIS PROBLEM WITH ZIP-GRIP®!

Slight variation of thread causes locking action on mating surface!

Proven as an outstanding principle in many products, Zip-Grip has found particular acceptance wherever the stress of movement or vibration occur. Makes an outstanding adjusting screw . . . Can be reapplied many times . . . Got an idea? Check No. 3.

Set Screw & Mfg. Co.

IDEA #4 TINY SCREWS DO BIG HOLDING JOB . . . THEY'RE CALLED "MINI-MITE"

You'll find them perfectly-produced counterparts to their big brothers!

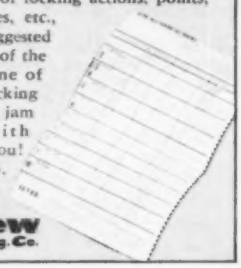
If miniaturization is one of the fields that you're interested in, then you'll see many good ideas in the perfectly-produced, money saving selection of Mini-Mites . . . Why pay for Specials when these can keep your costs at a minimum . . . Get the idea? Check No. 4.

Set Screw & Mfg. Co.

IDEA #5 NEW SELF-LOCKING SET SCREW SELECTOR CHART LISTS OVER 1,001 COMBINATIONS.

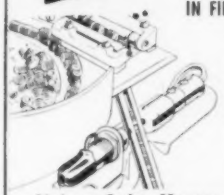
Helps you determine available combinations best for your particular application!

Here is another Setko first . . . A complete listing of locking actions, points, metals, drives, etc., including suggested applications of the complete line of Setko self-locking screws . . . It's jam packed with ideas for you! Check No. 5.



Set Screw & Mfg. Co.

IDEA #6 "SETKO HOPPER FEEDER SAVED US $42,000 IN FIRST YEAR."

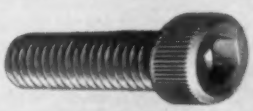


Here's the first truly Automated method of hopper feeding Headless Set Screws.

Unique Setko Hopper Feeder design orients headless Set Screws then feeds them to a driving device . . . Savings like the one shown above are but one of the advantages (name of mfr. on request) . . . Product quality is consistent, etc. This cost-cutting idea is one you can't miss! Check No. 6.

Set Screw & Mfg. Co.

IDEA #7 NOW YOU CAN GET COLD FORGED "PERFECT HOLE" CAP SCREWS IN THE NEW '60 SERIES . . . *and in STAINLESS STEEL, TOO!*



If you're a user of Cap Screws you'll want to examine these yourself . . . We know you'll get our idea of trying to produce a perfect product consistently . . . We're sure you'll appreciate their performance once you've tried them . . . Would you like test samples? We'll be glad to send them! Check No. 7 and indicate sizes, etc.

Set Screw & Mfg. Co.

IDEA #8 THERE'S A BARREL-FULL OF IDEAS IN THE NEW 28-PAGE SETKO CATALOG #23.

The complete line of cost-cutting SETKO Socket Screw Products is at your fingertips.

You'll want this compact catalog for your personal use . . . And you'll particularly like the easy to read manner in which it has been prepared. Want a copy? Check No. 8.

Set Screw & Mfg. Co.

Set Screw & Mfg. Co.

149 MAIN STREET, BARTLETT, ILLINOIS

Please send me Idea information on items checked below. (If FREE samples are wanted of any of these products, send your specifications).

- ☐ 1. Nu-Cup
- ☐ 2. Slabbed Head
- ☐ 3. Zip-Grip
- ☐ 4. Mini-Mite
- ☐ 5. Self-Locking Selector Chart
- ☐ 6. Hopper Feeder
- ☐ 7. Cap Screw
- ☐ 8. Catalog

NAME _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

For more information, turn to Reader Service card, circle No. 443

What's new IN MATERIALS

perature range —100 to 350 F.

KEY NO. 625

An improved, crystal-clear epoxy casting resin, called Maraglas No. 655, produced by Marblette Corp., Long Island City, N. Y., is said to have higher impact strength, greater resiliency and faster cure than the previously available resin. The cured product provides 90% light transmission. The resin is used for making bubble-free castings, prototypes, lighting fixtures, piping and decorative consumer items.

KEY NO. 626

Metal-Cast No. 405 AP is a general-purpose, 100% solids, filled epoxy casting resin recently introduced by Mereco Products Div. of Metachem Resins Corp., 530 Wellington Ave., Cranston 10, R. I. The developer says the material is suitable for use over the temperature range —75 to 390 F.

Another epoxy from Metachem Resins (address above) is Metal-Cast No. 441 which is a two-part, 100% solids epoxy casting compound. It is recommended for sealing, potting and encapsulating large items such as coils, resistors, transformers and other electronic parts. Its main feature is its adjustable flexibility, i.e., the cured material can be varied from a semi-rigid hard casting to a rubbery, flexible sealant.

KEY NO. 627

3. Impregnating resins

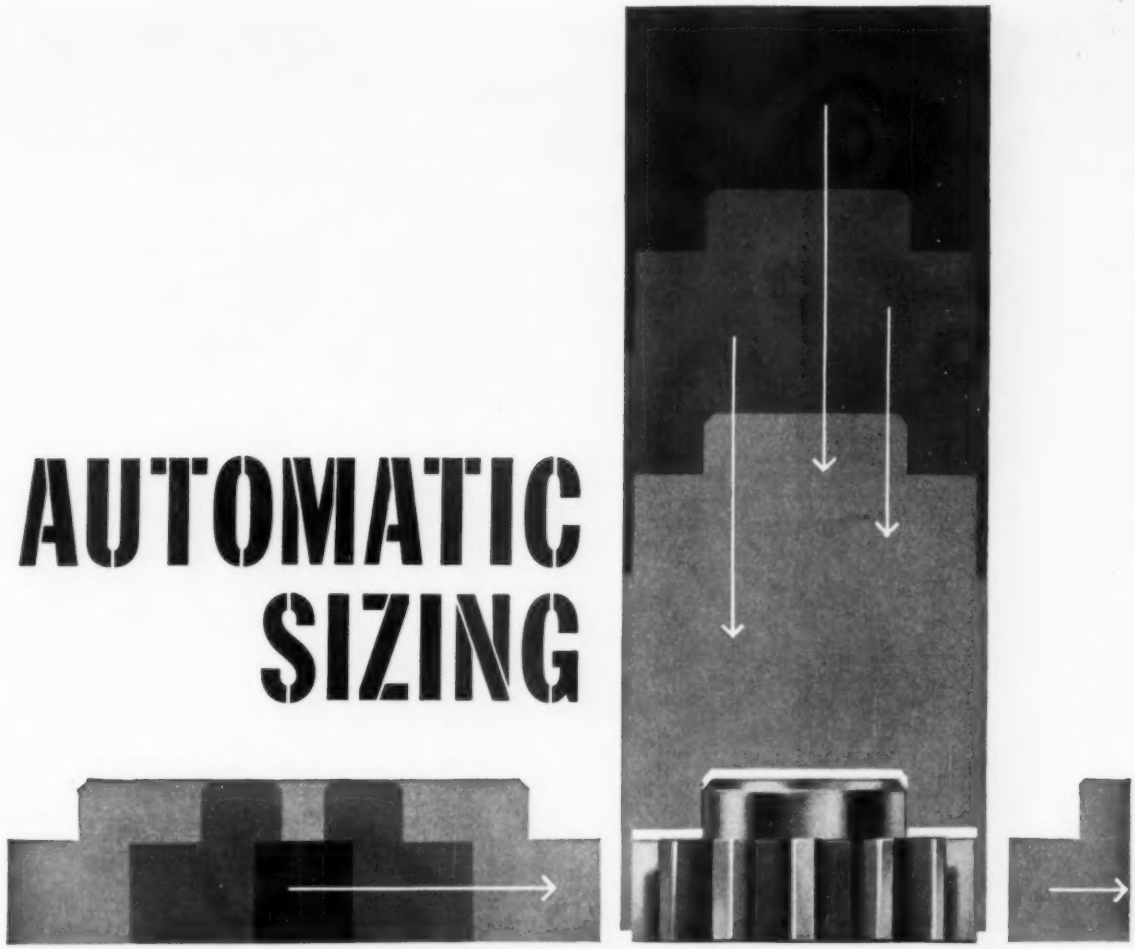
Epocast H-1338 is the name given to a new impregnating and encapsulating material supplied by Furane Plastics Inc., 4516 Brazil St., Los Angles 39. The material contains epoxy resins and coal tar derivatives. It is designed as an electrical insulation for transformers, terminal boards and other electrical parts.

KEY NO. 628

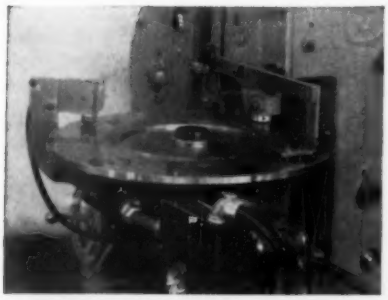
A one-part, nontoxic epoxy powder is expected to be used for encapsulating, sealing, embedding, impregnating and potting of semiconductors, modules and other electronic

WATCH FOR 'SELECTOR'—The fourth edition of M/DE's *Materials Selector*—revised, expanded and updated—will be published the middle of next month. The special issue is included in the M/DE subscription.

AUTOMATIC SIZING



speeds production of powder metal parts



The photo illustrates a modified Stokes compacting press, Model T-4, equipped with a special holding and feeding fixture for automatic sizing. This type of rotating fixture has proved highly successful in sizing small, complex parts.

Stokes brings new thinking, new designs to high-speed sizing of powder metal parts. With speed, accuracy, and minimum tool wear as design objectives, Stokes has modified many of its standard compacting presses for automatic high-speed sizing. The Stokes presses now in service are sizing a wide variety of powder metal shapes at high production speeds . . . and they are easily converted to operate either as sizing or compacting presses.

For special applications, Stokes offers such production-oriented design considerations as automatic feeders, orientation and inspection devices, and other innovations. It is this kind of advanced thinking that can keep you ahead of rising production costs . . . can help you plan for your future needs.

Consult Stokes Engineering Advisory Service on your specific powder metal application. You'll get professional assistance in designing parts, punches and dies, or complete production facilities. Technical information on the complete Stokes line of compacting presses is available on request.

STOKES

POWDER METAL PRESS DIVISION • **F. J. STOKES CORPORATION** • 5500 TABOR ROAD, PHILADELPHIA 20, PA.

For more information, turn to Reader Service card, circle No. 449

What's new IN MATERIALS

and electrical devices. The product, available from Epoxy Products, 137 Coit St., Irvington, N. J., is said to have good resistance to moisture and chemicals, and good electrical properties. KEY NO. 629

Plastics Films Resist Moisture Absorption

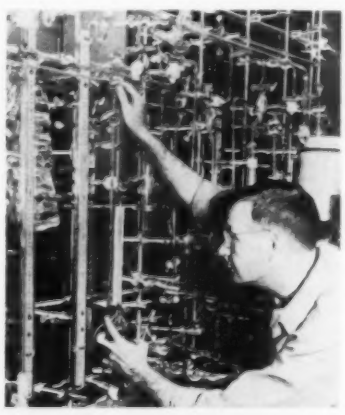
New fluorohalocarbon films featuring transparency and virtually zero moisture absorption are now available in pilot plant quantities from Allied Chemical Corp., General Chemical Div., 40 Rector St., New York.

The films, called Aclar, are expected to be used for packaging electronic and other delicate equipment, drugs and chemicals, according to the producer.

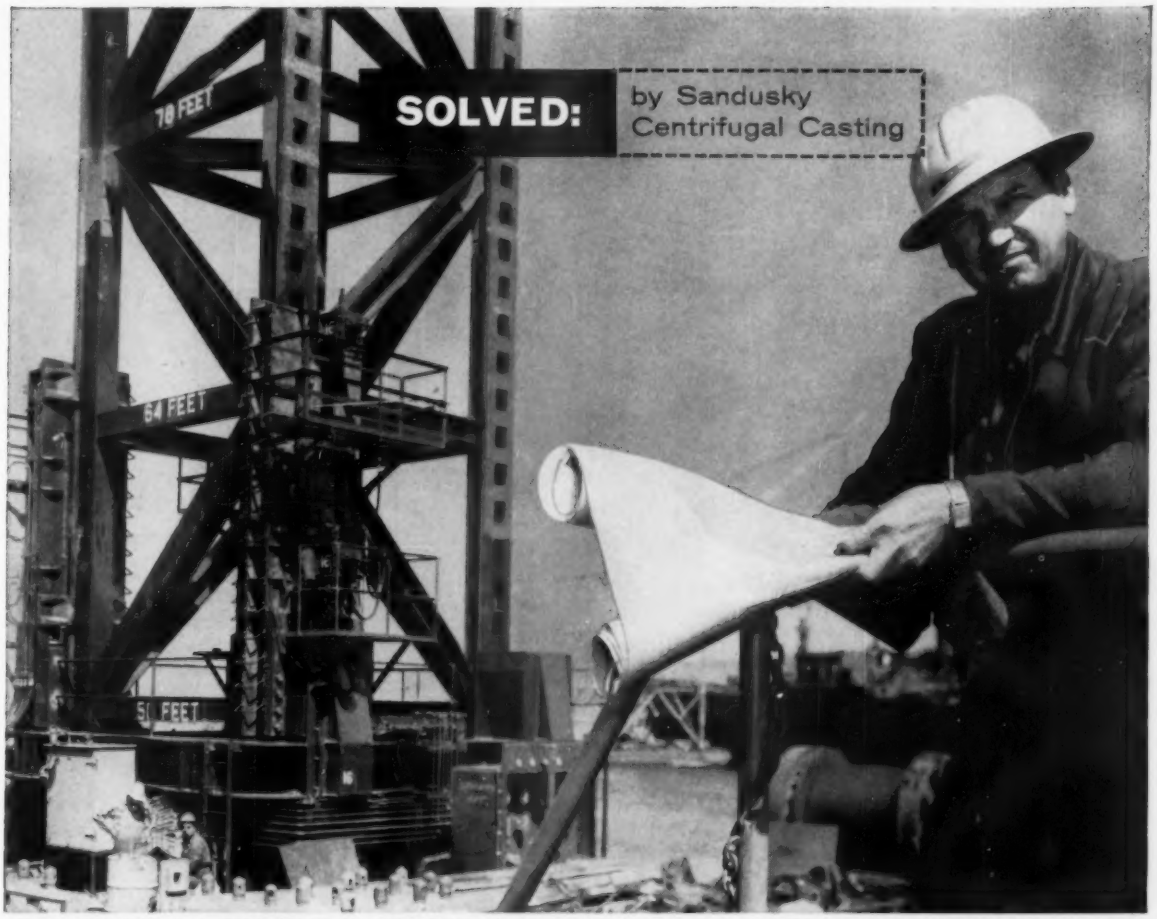
Better moisture barrier than other plastics films

F. J. French, president of Allied's General Chemical Div., says, "An outstanding characteristic of the films is their low moisture vapor transmission. For example, to get the moisture barrier benefits of Aclar type 33 film, a saran film would have to be over 100 times as thick, a polyethylene film over 400 times, and a polyester film over 700 times as thick."

The company says this extremely low moisture vapor transmission, plus transparency and good impact strength, permits the film to meet



***Permeability test** shows new plastics films have virtually zero moisture absorption.*



One of four 274 ft. high towers aboard the *George F. Ferris* showing method of installing hydraulic jacks built by Yuba Manufacturing Division, Yuba Consolidated Industries, Benicia, Calif. George Bauer, of Delong Corp., New York, is shown supervising construction while platform is being completed at Yuba's Richmond, Calif., plant.

YUBA gets quality-cost-delivery advantages by specifying 16 Sandusky cylinders

Sixteen 500-ton hydraulic jacks built by Yuba, for which Sandusky supplied the main cylindrical bodies, enable the new pipe-laying barge, *George F. Ferris*, to operate in waters 200 ft. deep!

This 5400-ton barge is equipped with four structural steel towers 274 ft. high. Four jacks on each of the towers provide the power to lower these steel "legs" to the ocean floor, raise the barge above the surface of the water, or retract the towers to render the barge navigable. The steel jack cylinders are Sandusky Centrifugal Castings, made to the requirements of ASME Code-approved SA-217, Section VIII, Unfired Pressure Vessels, to withstand operating pressures of 3000 psi. They were produced in 186" lengths, machined to 24" O.D. with 2" thick walls and sectioned into four pieces 43" long.

Yuba's selection of Sandusky Centrifugal Castings was based largely on three essential factors: QUALITY—meeting the exacting Code requirements . . COST—saving about half the cost of an alternate method of manufacture . . and DELIVERY—coming through on a tough time schedule by delivering all 16 cylinders within 21 working days!

When you need cylinders from 7" to 54" in O.D. and up to 33 feet long it will pay you to get in touch with us. Write for our latest booklet, *Your Solution To Cylindrical Problems* containing data on more than 70 ferrous and non-ferrous alloys.

SANDUSKY ® **CENTRIFUGAL CASTINGS**

FOUNDRY & MACHINE CO.

9902

SANDUSKY, OHIO—Stainless, Carbon, Low-Alloy Steels—Full Range Copper-Base, Nickel-Base Alloys

For more information, turn to Reader Service Card, circle No. 473

What's new IN MATERIALS

requirements of military specification MIL-F-22191 for packaging applications.

Other characteristics of the films:

1. They retain flexibility and other useful properties over the temperature range –320 to 390 F.
2. They resist most corrosive acids and alkalis. **KEY NO. 630**

Inconel Added to Line of Nuclear Tubing

Inconel tubing has been added to a line of nuclear quality heat exchanger tubing now available from Superior Tube Co., Norristown, Pa. The Inconel tubing is said to be highly resistant to corrosive attack, even with oxygen and chlorine ions present in the water. Thus, it resists cracking under stress-corrosion conditions.

The nuclear quality tubing is drawn from carefully selected tube hollows with closely controlled chemical composition; cobalt content is held to 0.10% or less, assuring minimum radiation hazards.

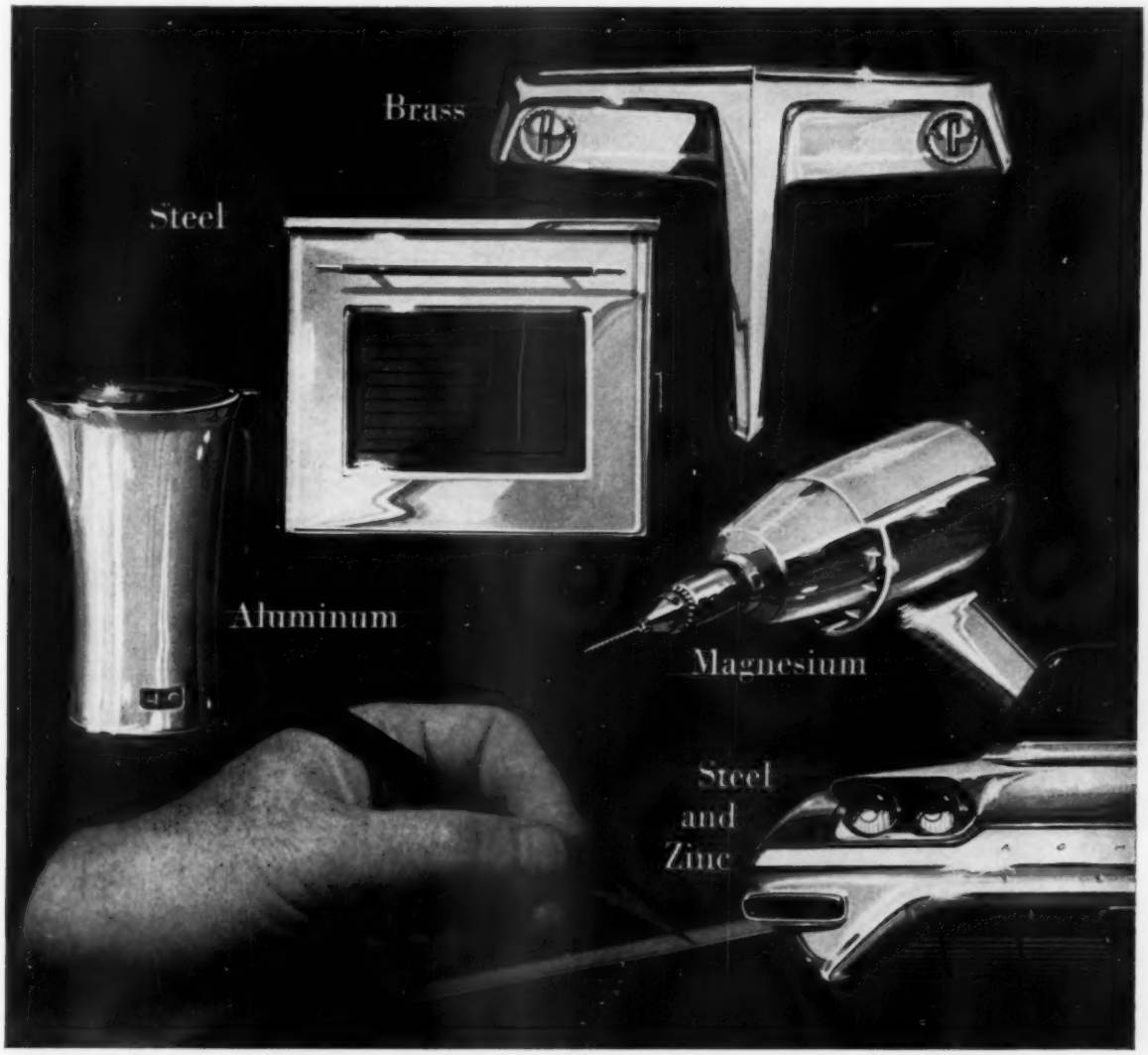
The Inconel heat exchanger tubing is furnished in sizes of 0.125 to ⅝ in. o.d. with wall thickness ranging from 0.0015 to 0.125 in. It is also supplied in sizes of ⅝ to 1⅛ in. o.d. with maximum wall thicknesses of 0.035 in. **KEY NO. 631**

Water Soluble Film Protects Brass Parts

A new water-base protective coating for use on brass and brass-plated steel parts has been introduced by Logo Div., Bee Chemical Co., 12933 S. Stony Island Ave., Chicago 33.

Parts are coated by dipping in a water soluble, noninflammable compound called Lacqua M-800. The producer says the clear coating resulting from the immersion treatment is identical in appearance to conventional lacquer and enamel films obtained with flammable organic solvent systems.

Parts coated with the compound can be soldered, and the coating can be removed by using commercial



Choose any basis metal you desire and give it

a lustrous, lasting finish of Nickel-Chrome Plating!

Nickel-Chrome Plating provides a practical way to combine the beauty and protection of Nickel and chromium with the special properties of other metals:

- formability of brass
- strength of steel
- extrudability of aluminum
- lightness of magnesium
- conductivity of copper
- design flexibility of zinc-base die castings

Today's adaptable Nickel-Chrome Plating gives you the freedom to use a wide variety of basis materials to achieve the most desirable combination of performance, fabricability *and* practical cost.

Select the basis material that proves most suitable. Nickel-Chrome Plating will give it lustrous, matching beauty with brilliant blue-white color. Beauty with outstanding durability, too.

That's because Nickel-Chrome Plating not only provides shining sales appeal, but also protects basis metals from rust and corrosion. Protects basis materials from nicks and scratches. Makes the lustrous beauty lasting beauty.

So with Nickel in ample supply as far into the future as any man can foresee, there's no better time than now to use Nickel-Chrome Plating to your product's best advantage. Whether you want smoothing action, blue-white brilliance or satin tones—together with long-lasting protection—there's a Nickel coating to fit your requirements.

For information on accelerated corrosion testing of plated coatings, just drop us a card for your copy of "CORROSION TESTING OF ELECTRODEPOSITED COATINGS."

The International Nickel Company, Inc.
67 Wall Street New York 5, N.Y.

INCO

Inco Nickel

Nickel makes plating perform better longer

For more information, turn to Reader Service card, circle No. 387

Whatsnew IN MATERIALS

alkaline stripping compounds.

Properties of coating

Salt spray resistance—Tests showed that brass-plated steel specimens coated with Lacqua M-800 withstood 96-hr exposure to salt spray with no edge creep from the side and no spotting on the face of the specimens.

Moisture resistance—Coated specimens withstood 1400-hr exposure to 100% RH at 110 F with no visible damage.

Impact resistance—Coated specimens withstood 30 in-lb reverse impact tests with no fractures.

KEY NO. 632

Modified Nylon Has Improved Properties

Better uniformity of all properties regardless of section size, improved molding properties, and minimum moisture distortion are said to be the chief characteristics of a modified, type 6 nylon molding resin.

Key to the resin's improved properties is its fine crystalline structure: it has a maximum spherulite size of 2.1 μ at 400X magnification, compared to 17 to 26 μ for unmodified type 6 nylon.

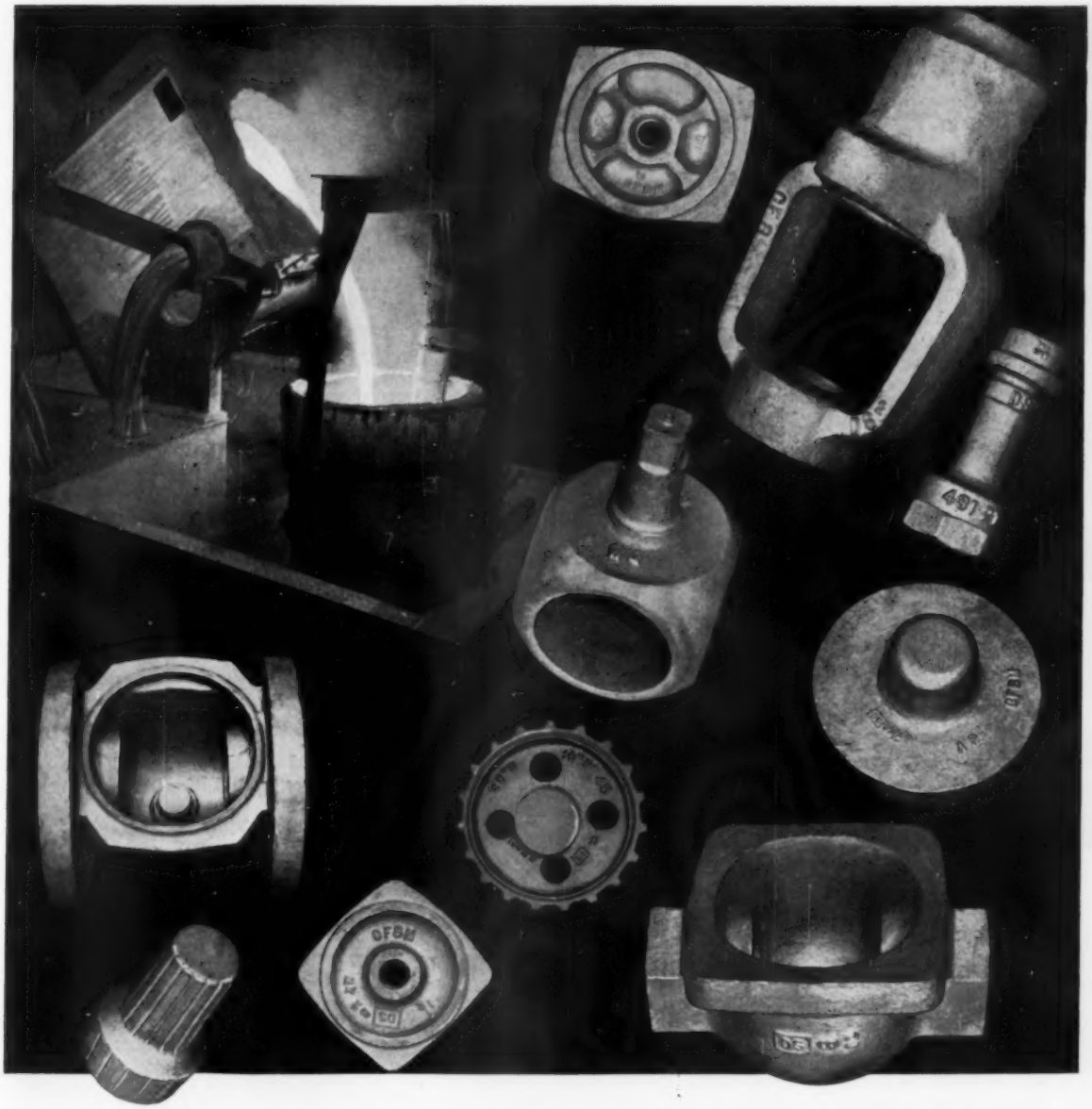
The fine crystalline resin is available from Foster Grant Co., Inc., 289 N. Main St., Leominster, Mass. It is called Fosta nylon modified type 6. KEY NO. 633

Printed Circuits Withstand 1800 F

A newly developed ceramic circuit board with a printed metal circuit can be subjected to temperatures up to 1800 F without failure, according to Mitronics Inc., 1290 Central Ave., Hillside, N. J. The printed circuit board is also said to withstand high humidity and corrosive environments.

The circuit board is 96% alumina on which is screened a metal printed circuit composed of molybdenum and manganese. The metal circuit is protected with an electroplated coating of nickel or copper which serves as a base for hard or soft solders.

The ceramic circuit boards can be



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Perhaps one or more DS castings shown here will help spark an idea of how Dodge can be of assistance for *your* stainless steel casting needs. A blueprint or sketch with operational details will bring complete information, without obligation.

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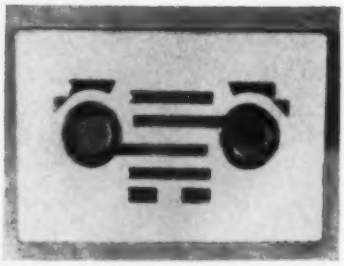
What's new IN MATERIALS



***Ceramic circuit board** with molybdenum-manganese printed circuit.*

made in sizes up to 18 sq in. Pattern configurations can be screened on the ceramic boards to tolerances of ±0.005 in. **KEY NO. 634**

Coating Adheres to Uncleaned Aluminum

A new synthetic baking enamel can be applied directly to uncleaned and untreated aluminum. It was developed by Cosden Paint Co., Beverly, N. J. Available clear or pigmented, the coating is particularly suited for use on foil packaging, gift wrapping and containers.

The high-gloss coating is said to form a tough, abrasion resistant film which will not scratch or rub off. It can be applied by spray or roller coating methods. Baking schedules vary from 10 sec at 500 F to 15 min at 300 F.

The developer says the coating has excellent coverage because of its high solids content. For example, 1 gal of the coating will cover over 3000 sq ft of 0.0002-in. thick aluminum foil. **KEY NO. 635**

Adhesives for Bonding Rubber, Plastics, Metals

New adhesives now on the market include: 1) a water-base adhesive for dry bonding supported and unsupported materials; 2) a rubber-base adhesive for bonding urethane foams; 3) a translucent adhesive that permits delayed assembly of various products; 4) a fast drying adhesive for bonding rubber and plastics foams; and 5) a urethane

where can you use **WATER SOLUBLE** coatings?

A NEW FAMILY OF NON-FLAMMABLE COATINGS THAT BECOME WATER INSOLUBLE ON APPLICATION

Protective clear films for metal protection—some superior even to the high bake enamels or lacquers—can be produced by use of the new LACQUA coatings developed by BEE CHEMICAL COMPANY.

APPLICATIONS UNLIMITED

LACQUA has aroused high interest in many industries and is in current use in the electroplating field (see right). It is also being evaluated in the *steel processing*, *automotive*, *electronic*, *textile*, and *paper fields*, to name a few.

Its use as a primer to replace either the flammable coatings or emulsion coatings for auto underframes, structural and sheet steel, and as a coating for aluminum foil are under study.

APPLICATION METHODS

Although primarily developed for dipping, tests indicate the LACQUA products may also be applied by airless spraying or by roller coating.

COOPERATIVE DEVELOPMENT

Our Field Product Development Department welcomes the opportunity of cooperating with you to determine the merits of one of this family of highly unique coatings for your application.

ADOLPH PLATING INSTALLS LACQUA M-801 INTO PLATING LINE

Adolph Plating, Inc., Chicago, one of the largest job plating firms in the country, has installed LACQUA M-801 into its regular plating line. Shown in photo above, Adolph Plating's sales manager, Ray Giesel (right) discusses the system's advantages with production manager, Richard Giesel. The coated parts shown are zinc-plated tubing dipped in LACQUA M-801. They will be used in the manufacture of home movie screens.

Adolph plating specializes in cadmium, zinc and copper plating and is now offering the LACQUA protective coating to its customers in the automotive, electronic and metal fabricating industries.

Bee chemists check results of an independent laboratory test conducted by Accurate Engineering Laboratories, Chicago. Brass-plated panels coated with LACQUA M-800 withstood 96 hours salt spray exposure, with only slight edge creep. Panel at left, a leading water soluble lacquer, showed complete failure after 48 hours exposure.

☐ I want to evaluate the LACQUA coatings for application on:

_____

_____

We manufacture: _____

Type of protective coating now used: _____

_____

☐ Enter my order for a trial quantity of LACQUA at $5.60/gallon for:

☐ 1 gallon ☐ 5 gallons ☐ 25 gallons

of the LACQUA product best suited for the above application.

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What's new IN MATERIALS

adhesive for bonding rubber to metal.

1. Water-base adhesive

Vinylstix Heat Seal is the name given to a new, water-base adhesive designed for dry bonding supported and unsupported plastics, cotton, wool, leather, paper, cellulose acetate and other materials. A strong bond forms between materials coated with the adhesive when heat is applied.

The new product is marketed by Adhesive Products Corp., 1660 Boone Ave., New York 60. KEY NO. 636

2. Rubber-base adhesive

A clear, rubber-base adhesive has been formulated especially for bonding urethane foams or rubber foams to themselves. Called Rez-N-Glue No. 301, it is available from Schwartz Chemical Co., Inc., 50-01 2nd St., Long Island City 1, N. Y. The fast drying adhesive is said to produce a translucent bond.

KEY NO. 637

3. Translucent adhesive

A translucent, amber colored adhesive that retains tackiness for several hours is said to permit delayed assembly of trim fabric, insulation and similar materials to metals and fiberboard. It is called Rez-N-Glue No. 164, and is available from Schwartz Chemical Co. (address above). Composition has not been revealed.

The producer says no unsightly residue results from use of the adhesive as is the case with red or black adhesives. Bonds are said to be tough and resistant to heat, cold and water. One gallon of the translucent adhesive will coat approximately 250 sq ft. KEY NO. 638

4. Fast drying adhesive

A fast drying adhesive for bonding foam rubber, urethane foam and vinyl foam to themselves and to leather, wood, fabrics and other porous materials has been developed by Rubba, Inc., 1015 E. 173rd St., New York 60.

Called Rubbafoam, the adhesive is said to leave an almost invisible glue line in bonded products. Its composition has not been disclosed.

KEY NO. 639

5. Urethane adhesive

A room-temperature-curing urethane adhesive for bonding rubber to metal is now available from Plastic Associates, 2900 S. Coast Blvd., Laguna Beach, Calif. The two-part

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SIZE RANGES: Tubes are produced in lengths from 4' to 20'; longer lengths are made by welding. O.D.'s from 2.25" to 50" — wall thicknesses from .25" to 8".

ANALYSES: All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steels, plain carbon steel and special non-standard analyses.

FINISHES: As cast, rough machined, or finish machined, including honing and grinding. Complete welding and machine shop facilities are available.

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adhesive, called PA-820, is suitable for such applications as attaching rubber feet to metal instrument cases, and installing flexible seals on cabinet doors. KEY NO. 640

Rubber-Epoxy Paints Are Solvent Resistant

A series of protective coatings with good chemical, solvent and abrasion resistance has been developed by Cosden Paint Co., Beverly, N. J. The coatings are mixtures of polysulfide liquid polymers and epoxy resins.

The developer says the liquid polysulfide polymers which form flexible, elastomeric films with good solvent and weathering resistance are blended with epoxy resins which provide hard, chemical resistant films that adhere to many types of materials.

Made in several formulations

The new coatings are supplied in several formulations ranging from solvent systems to 100% solids. Special systems are available for coating wet concrete, wood, and rusty steel. Most of the coatings cure over a wide temperature range, some as low as 40 F.

Potential uses include coatings for equipment exposed to corrosive chemicals, electrical insulating coatings, marine coatings, nonskid surfacing, electrical conducting coatings, and patching compounds.

KEY NO. 641

Oriented TFE Sheets Keep Their Shape

A new TFE sheet material is said to keep its shape better than conventional TFE sheets. Reason: the product undergoes an orienting process in which a sintered TFE sheet is further compacted by pressing in a hydraulic press. The process is said to substantially reduce both initial deformation and long-time creep of TFE sheet materials.

The developer, Cadillac Plastic & Chemical Co., 1511 2nd Ave., Detroit, says a big use for the oriented sheet material will be gaskets. Tests show that loadings on oriented TFE

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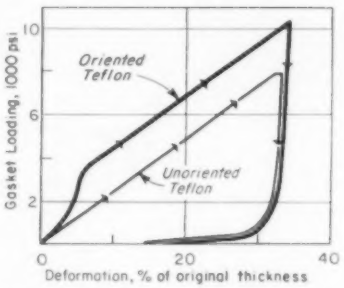
What's new IN MATERIALS



***Compression and recovery** of oriented vs unoriented TFE at 73 F. Compression of gaskets was measured with a dial indicator at four points on platen of tester. Gasket size was 7½-in. i.d. by 8½-in. o.d. Oriented TFE gasket was 0.134 in. thick; unoriented gasket was 0.136 in. thick.*

gaskets can be increased by as much as 25% without increasing the percentage of deformation.

The sheet material is supplied in sizes up to 48 by 48 in., in thicknesses from 1/32 to 2 in.

KEY NO. 642

O-Ring Compounds Withstand Heat, Fuels

Two companies have recently developed new heat and fuel resistant rubber compounds for use in o-rings, and molded and extruded shapes.

1. Fluorosilicone compound

Stillman Rubber Co., 5811 Marilyn Ave., Culver City, Calif. is marketing a compound called TH-1047 that is based on fluorosilicone rubber.

The compound has a Shore A durometer hardness of 50 to 55, and good resistance to JP-4 jet fuel, Skydrol and other hydraulic fluids. The compound is said to maintain its physical characteristics over the temperature range —75 to over 400 F.

The company says o-rings and molded shapes made from the compound meet military specification MIL-R-25988. KEY NO. 643

2. Viton B compound

Haveg Industries, Inc., Taunton Div., 336 Weir St., Taunton, Mass. has developed a Viton B compound that is said to have good resistance

PROPERTIES OF NO. 16075 O-RINGS

Property	MIL-R-25897C	16075
Ten Str, psi	1600 min	2300
Elong, %	175 min	180
Hardness, Shore A	75±5	75

to high temperatures, aromatic fuels and hydraulic fluids. The developer says the compound was formulated to provide good compression set resistance under severe operating conditions.

The material, designated Grade No. 16075, can be extruded or molded into o-rings and other shapes. It is approved under military specification MIL-R-25897C. **KEY NO. 644**

Rosin Solder Flux for Electronic Use

A mildly activated rosin-type solder flux called Fusion RU has been developed by Fusion Engineering, 17921 Roseland Ave., Cleveland 12. The flux is suitable for electrical and electronic applications where nonconductive, noncorrosive flux residues are required. Humidity chamber tests show the flux is noncorrosive after soldering.

The developer says the flux can wet mild steel, brass, copper, tin, lead, and cadmium and silver electroplates. **KEY NO. 645**

Foam Plastic Sheet for Insulation, Packaging

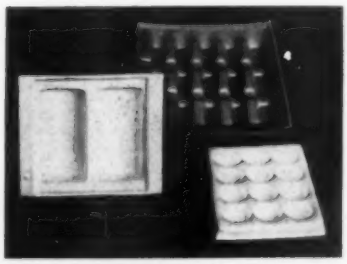
Expanded polystyrene sheet combining several properties that make it suitable for packaging, thermal insulation and similar uses is now available from the Dyna-Foam Corp., Ellenville, N. Y.

A thin film of Dyna-Foam is said to provide efficient insulation against temperatures from –425 to 212 F. The manufacturer says that it is also very resilient, lightweight, waterproof, chemically inert, nonabrasive and decorative.

Films and sheets are available up to 60 in. wide and in lengths comparable to the largest paper rolls. Special shapes and thicknesses are

What's new IN MATERIALS

Resiliency *of a sheet of Dyna-Foam 0.08 in. thick is demonstrated by dropping a raw egg from a height of 1 ft.*



Fitted packaging platforms *for bottles and other breakables are made of Dyna-Foam expanded polystyrene. Custom-fitted packing can also be produced for such other items as candy, crackers and light bulbs.*

available for specific applications.

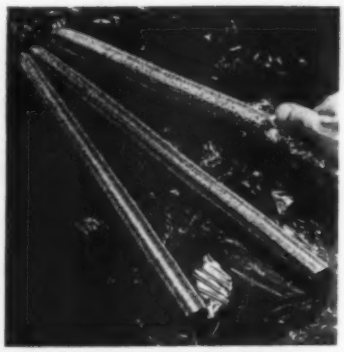
Dyna-Foam is made by vacuum or press forming at about 220 F from polystyrene pellets. Gas within the pellets expands and foams the plastic. KEY NO. 646

High Purity Silicon for Semiconductor Devices

High purity silicon in polycrystalline rod form is now being produced by Dow Corning Corp., Midland, Mich. The producer says the rods are produced by a method that assures greater purity than casting.

By vacuum zone refining, the polycrystalline rod can be converted to

What's new IN MATERIALS



***Silicon rods** have a high degree of purity and uniformity.*

single-crystal silicon having a resistivity greater than 1000 ohm-cm, and a minority carrier lifetime greater than 400 sec.

The rods are supplied in diameters up to 1 in. and in lengths up to 17½ in. They sell for about $300 per lb.

KEY NO. 647

RTV Rubber's Viscosity Lowered with Thinner

A new, inert silicone oil for adjusting and controlling the viscosity of RTV (room temperature vulcanizing) silicone rubber is now commercially available from Dow Corning Corp., Midland, Mich.

A big advantage of the product, called RTV thinner, is that it can be used to maintain an RTV system that is free from volatile solvents.

The material can reduce the viscosity of RTV rubber by as much as 75% without significantly changing the physical properties of fully vulcanized rubber, according to Dow Corning.

KEY NO. 648

Large, Hollow Plastics Extrusions

Very large, hollow plastics extrusions are now possible as a result of a new extrusion technique (details not disclosed) developed by Anchor Plastics Co., 36-36 36th St., Long Island City 6, N. Y. An example of a part that can be made

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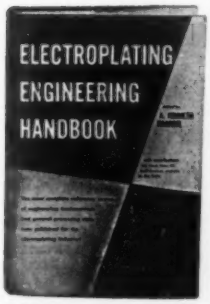

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What's new IN MATERIALS

***Typical part** that can be made by Anchor's new extrusion technique.*

by the process is a rectangular polystyrene tube measuring 3 by 7 in.

Typical applications for which the process is suited are ducts, dispensing displays, and containers where more than one height is required.

KEY NO. 649

Other News . . .

Metals

▸ Riverside-Alloy Metal Div. of H. K. Porter Co., Inc., Riverside, N. J. says it has added types 302, 304 and 316 to its line of Isoloy stainless steel spring wires. KEY NO. 650

▸ Stainless steel-clad welded carbon steel tubing is now available from Standard Tube Co., 24400 Plymouth Rd., Detroit 39. The tubing is supplied in sizes up to 3½ in. o.d., and in composite wall thicknesses up to ¼ in. KEY NO. 651

Plastics

▸ A line of wood-grained plastics moldings for use as trim has been introduced by Glass Laboratories Inc., 863 65th St., Brooklyn 20, N. Y. The moldings, called Silvatrim, are supplied in over 150 different cross sections. KEY NO. 652

▸ A new, low cost method for molding thermoplastics will be used by American Agile, Cleveland; Amos Molded Plastics, Edinburg, Ind.; Loma Plastics, Fort Worth, Tex.; Rubbermaid, Wooster, Ohio; and Space Structures, Inc., Chanhassen, Minn. for making large plastics products. The technique, described in the Mar '60 issue of this maga-

zine (p 10), works by fusing thermoplastic materials together in inexpensive molds. **KEY NO. 653**

▸ Cast Optics Corp., 1013 Newman St., Hackensack, N. J. has introduced cast acrylic corrugated sheets in a variety of colors. The sheets are called Evr-Kleer. **KEY NO. 654**

▸ Dorak Products Corp., 78 Pearl St., New York 4 is marketing vinyl and polypropylene perforated sheets. Called Filter-Mesh, the unplasticized materials can be used to filter acids, alkalis, solvents and salt solutions. **KEY NO. 655**

▸ Six new large sheet sizes of Formica laminated plastics have been announced by Formica Corp., 4614 Spring Grove Ave., Cincinnati 32, Ohio. The new sheet sizes are 30, 36, 48 and 60 by 144 in., 60 by 96 in. and 60 by 120 in. **KEY NO. 656**

▸ A new polyethylene resin is said to produce film of exceptional clarity and high gloss. The resin, designated Petrothene 218, is marketed by U. S. Industrial Chemicals Co., Div. of National Distillers and Chemical Corp., 99 Park Ave., New York 16. **KEY NO. 657**

▸ A clear, fully transparent vinyl tubing that shrinks under heat to provide a tight covering for either symmetrical or gently contoured shapes is now available from Irvington Div., Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn. The tubing, called ScotchTite, has previously been available only in black. **KEY NO. 658**

Other nonmetallics

▸ A low cost, low density insulating fill is now available from Johns-Manville, 22 E. 40th St., New York 16. The material, called Perlox, is especially suitable for insulating liquid oxygen and liquid hydrogen. **KEY NO. 659**

▸ Two new thread sealants for storable rocket propellant systems are available from Redel Inc., 220 N. Atchison St., Anaheim, Calif. Reddy-Lube No. 100 is compatible with nitrogen tetroxide and Reddy-Lube No. 200 is compatible with dimethyl hydrazine. **KEY NO. 660**

▸ A highly stable, concentrated dispersion of colloidal, molybdenum disulfide in isopropyl alcohol has been developed by Acheson Colloids Co., Div. of Acheson Industries, Inc., Port Huron, Mich. The dispersion, called 'dag' No. 210, is said to form a tightly adherent film on a variety of substrates. **KEY NO. 661**

▸ A heavy weight, high wet strength paper is available from Paterson Parchment Paper Co., Bristol, Pa. for use as casings in oil filters and as tags. The paper is supplied in sheets and rolls in widths up to 72 in. **KEY NO. 662**

▸ A line of ceramic shapes, including bushings, washers, rods, disks and plates, for use at temperatures up to 2100 F is being marketed by Duramic Products, Inc., 426 Commercial Ave., Palisades Park, N. J. The ceramic material (composition not disclosed) is said to have excellent thermal shock resistance. **KEY NO. 663**

▸ Carey-Canadian Mines, Ltd., P.O. Box 95, Cincinnati 15, Ohio has introduced two new asbestos materials for reinforcing plastics. The fillers are called 7RF-9 and 7TF-8. **KEY NO. 664**

Finishes

▸ A heat resistant paint for protecting steel jigs, fixtures and formed steel products during brazing and welding operations has been developed by Speco, Inc., 7308 Associate Ave., Cleveland 9. Known as Heat-Rem H-170 Super, the paint is said to withstand temperatures up to 1700 F. **KEY NO. 665**

▸ John L. Armitage & Co., 245 Thomas St., Newark 5, N. J. has developed a clear thermosetting coating for use in vacuum metallizing plastics parts. A base coat is first applied to a part, baked, then vacuum metallized. A top coat is then applied over the metallized part and baked. **KEY NO. 666**

▸ A clear urethane coating is said to restore high gloss to rubber products dulled by manufacturing processes. The coating, developed by Cosden Paint Co., Beverly, N. J., is said to have the ability to elongate as the rubber stretches, and then return to its normal state without cracking or checking. **KEY NO. 667**

▸ CuSol is the name of a new plating process that is said to deposit a copper electroplate having good ductility and smoothness. The process, developed by Seymour Mfg. Co., Seymour, Conn., can be used to plate steel, zinc, tin and other metals. A CuSol plating solution is said to be stable and free of break-down products. **KEY NO. 668**

Fastening

▸ Project Fabrication Corp., 112-20 14th Ave., College Point 56, N. Y. is marketing a metallurgically bonded stainless steel-aluminum coupling for joining stainless steel pipe to aluminum pipe without flanges or gaskets. **KEY NO. 604**

Advertisers & Their Agencies

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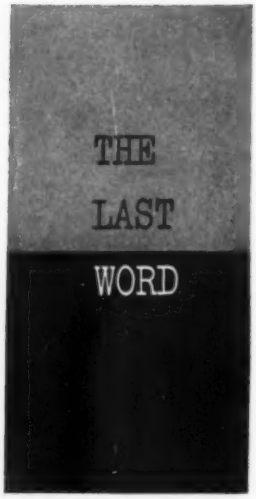
Do We Need a Plastics Institute?



by H. R. Clauser
Editor

For a number of years this question has been asked and discussed by a great many people concerned with the production, processing and application of plastics. Now, developments in recent months seem to indicate that the question will soon be answered one way or the other.

Committee surveys support

During the past year, a committee made up of people from various segments of the plastics field has developed a definite plan for establishing a Plastics Institute of America, and it has been working hard to gain the necessary support for the project. Two industry-wide surveys have been completed and a third is underway. Briefly the Institute, as outlined in the prospectus, would be an industry-supported research, education and information center whose major objectives would be to advance the frontiers of knowledge of plastics and to increase the supply of plastics engineers and scientists.

Plastics societies not in accord

Thus far the committee reports that the results of its surveys have been definitely encouraging. However, as is to be expected when an industry-wide project of this magnitude is proposed, there are differences of opinion. These differences are best seen, perhaps, in the stands taken by the two major plastics organizations. Strong support for the Institute has come from the Society of Plastics Engineers, which has contributed $8000 toward the initial expenses entailed in exploring and publicizing the project. The Society of the Plastics Industry, Inc., on the other hand, has not given its support to the project.

Though officially SPI has taken a neutral position, judging from the content and wording of a six-page "general bulletin" it issued in August there can be little doubt as to where SPI really stands on the issue. Nowhere in the bulletin is SPI's position directly stated. But a series of questions and answers attempts to show that present research and educational efforts are quite adequate, thus leading the reader to conclude that there is no need for a Plastics Institute.

Users and producers differ on need

The different positions taken by SPE and SPI on the Plastics Institute question are largely reflections of the differences in the membership and character of the two groups. Thus, SPE is heavily oriented towards plastics converters, processors and users who have most need for the kind of help a Plastics Institute would provide. On the other hand SPI has greater representation among the basic materials producers. The materials producers have extensive research facilities and programs of their own, and apparently feel that the benefits they would derive from a Plastics Institute would not be worth the additional financial outlay.

We have previously expressed ourselves in favor of the Plastics Institute (see M/DE, Nov 1959, p 256). We believe that group research of this kind benefits all—plastics producers, processors and users alike. The Institute plan offers a sensible solution to the many small and medium-size companies who need the results of research but who cannot afford to go it alone. The Institute would minimize duplication of effort in many areas, e.g., in evaluating performance properties and developing testing methods and standards. And it would serve as a focal point for studies on the fundamental structure of polymers, which would lead to improvements in production, processing and application of plastics, and in turn to greatly expanded use of plastics.

Companies benefit from industry progress

Finally, in evaluating the pros and cons of a Plastics Institute, it might be worthwhile for the plastics industry to look over the fence at the experience of the metals field. Until recent years most companies in the metal producing industries went their separate ways in research. Except where defense money was available, progress was slow and little fundamental research was undertaken. Only after other materials started to make serious inroads into their markets did the metal producers come to accept the general rule that the healthy progress of individual companies depends in large measure upon the progress of the industry as a whole.

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